

## XXIX. NOTES ON THE HABITS OF INDIAN INSECTS, MYRIAPODS AND ARACHNIDS.

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(Plates XXII—XXV).

The preparation of a course of popular lectures during the summer of 1914 necessitated the completion, so far as opportunity permitted, of a number of more or less casual observations that I have chanced to make from time to time on the habits of insects and spiders of Calcutta, and the production of figures to illustrate them. The present, therefore, seems a favourable opportunity of putting on record both these and certain observations made in other parts of India, in Burma and in Ceylon during the last five or six years, incomplete though they are in some cases.

Although a number of notes on the habits of Indian insects have been published from time to time, they are still regrettably few, considering the richness and interest of the fauna with which they deal; and they are so scattered that the discovery of their existence, by anyone in a position to make use of them, is a matter of great uncertainty.

In order to bring all these notes together search would have to be made through a number of European journals; but the results of such a search would probably be very small in comparison with the amount of time it would occupy. Indeed, the time would probably be better employed in making fresh observations.

Since, however, observations on living Indian animals must almost necessarily be made in India, many of them will naturally be recorded in Indian journals, which are comparatively few. And I have tried, in the following pages, to combine with the record of my own observations such references to those of others as I have been able to find in journals, chiefly Indian, up to the end of 1914. The necessity for this became more and more apparent as the work of compilation progressed; for I found that several of my own observations were simply confirmatory of those of others; and that in several instances observations having a very definite bearing upon one another were recorded by different authors, sometimes in different parts of the same journal, without any reference to one another.

It has been extremely difficult to find convenient limits to the subject in hand; for notes on habits pass by almost imperceptible gradations into notes on mimicry, development, crop-protection, sanitation, etc. I have not attempted to go through the rapidly increasing literature on Indian "economic" entomology; because, although it undoubtedly contains much that is of scientific interest, I doubt whether the records obtained would be worth the time involved—especially as a large proportion of these have already been brought together in Lefroy's "*Indian Insect Life*", Patton and Cragg's "*Text-book of Medical Entomology*", Fletcher's "*South Indian Insects*", and Stebbing's "*Indian Forest Insects*", text-books all of comparatively recent date.

Nor have I attempted to go through all the literature on Indian Butterflies, a very large proportion of which appears in the Journal of the Bombay Natural History Society. Much of the earlier work done on this group was brought together in Marshall and de Nicéville's well known "*Butterflies of India, Burma and Ceylon*." It may therefore be mentioned here that the Indian Museum possesses the latter author's file copy of this work, extensively interleaved with published and unpublished notes and figures, and continued in manuscript to deal with Pierinae and Papilioninae. The remaining parts were sent to Col. Bingham for use in connection with the unfinished butterfly volumes of the "Fauna of British India" series, and unfortunately appear to have been lost at the time of his death.

Such observations on butterflies and their larvae and pupae as have come under my notice have been carefully sifted, and only those that seem likely to be of general interest have been referred to below. But in other groups recorded observations are so comparatively few that even the most trivial often seems worth noting; and I have thought it best to include as wide a range of them as possible. I am indebted to Dr. N. Annandale, Mr. T. Bainbrigge Fletcher, Mr. C. Beeson and Mr. E. E. Green for a number of references. I am also indebted to these and other observers for several original notes, each of which is separately acknowledged.

## INSECTA.

### THYSANURA.

Cunningham ("Plagues and Pleasures"<sup>1</sup>, p. 190) notes that "fish-insects" prefer "size" to paper, but eat the latter also. Lefroy (*J.B.N.H.S.*<sup>2</sup> XIX, pp. 1006-7), who used *Acrotelsa collaris*, Fabr., as food for the larvae of *Croce filipennis*, Westw., reared the former from the egg, feeding it entirely on paper. The eggs, which were white, soft, and of an oval shape, were laid loosely among the paper.

<sup>1</sup> "Plagues and Pleasures of Life in Bengal", by Lt.-Col. D. D. Cunningham, C.I.E., F.R.S. (London, 1907).

<sup>2</sup> *Journal of the Bombay Natural History Society.*

DERMAPTERA.<sup>1</sup>

Burr notices the habits when attracted to light of *Labidura lividipes* (J.A.S.B.<sup>2</sup> [n.s.], II, p. 391), and the feeding habits, etc., of *Diplatys gladiator* (J.A.S.B. [n.s.], VII, p. 772). The attraction of a giant stinging nettle for various kinds of earwigs is also noted in the latter place.<sup>3</sup>

The habits and development of *Diplatys longisetosa* and *D. nigriceps* are described by Green (Trans. Ent. Soc. London, 1898, pp. 381-390, pl. xviii and xix).

Willey records the maternal instincts of a Ceylonese earwig (*Spolia Zeylanica*, VI, p. 53).

## ORTHOPTERA.

## Blattidae.

Annandale notes that *Pseudoglomeris flavicornis* lives under the bark of trees (Mem. A.S.B., I, p. 207).

C. Driberg notes that cockroaches are common in beehives in Ceylon and appear to attack the combs (*Spolia Zeylanica*, IV, p. 33).

Annandale (J.A.S.B. [n.s.], II, pp. 105-106) and Shelford (Rec. Ind. Mus., III, p. 125-7) refer to the amphibious habits of cockroaches of the genus *Epilampra*. These cockroaches are common among stones at the edge of streams in many parts of India.

Green (*Spolia Zeylanica*, VI, p. 135) and Annandale (Rec. Ind. Mus., V, pp. 201-2) describe cockroaches (*Periplaneta australasiae* and *americana* respectively) preying upon winged termites.

*Leucophaea surinamensis* is ovo-viviparous. When the egg-capsule is protruded it splits along one side, and the young (about 30 in number) at once escape, leaving what looks like a mass of exuviae behind with the capsule. This observation was made at Peradeniya.

## Phasmidae.

The development and habits of *Phyllium scythe* and *Pulchriphyllium crurifolium* are described by Murray (Edinburgh New Phil. Journ. [n.s.], III, pp. 96-111, pl. vi-viii), Morton (Bull. Soc. Vaud. Sci. Nat., XXXIX, pp. 401-7, pl. iii), St. Quentin (Entomologist, XL, pp. 73-75 and 147, pl. iv) and Leigh (Proc. Zool. Soc. London, 1909, pp. 103-113, pl. xxviii; Rep. and Trans. Manchester Ent. Soc. 1912, pp. 22-29). Green records an authenticated case

<sup>1</sup> See also Annandale "Notes on Orthoptera in the Siamese Malay States", Ent. Rec., XII, 1900, pp. 75-77 and 95-97.

<sup>2</sup> Journal of the Asiatic Society of Bengal.

<sup>3</sup> The statement in the same place that *Labidura riparia* and *bengalensis* occur under stones between tide-marks by the Chilka Lake must not be taken to imply that this insect is amphibious, for this lake has since been found to have its level so greatly affected by winds and by flooding that regular tides can scarcely be said to exist. High-water marks at all times are more likely to be due to the most recent flood than to a tide (see Mem. Ind. Mus. V, pp. 10-11, pl. i).

of parthenogenesis in the latter species (*Spolia Zeylanica*, VII, p. 54).<sup>1</sup>

T. V. Ramakrishna Aiyer describes the life-history of stick-insects hatched from eggs laid in a group on a wooden rafter instead of singly and loose (*J.B.N.H.S.*, XXII, pp. 641-3, 1 pl.).

I have never seen any record of the fact that, in some Phasmids at least, copulation and oviposition go on simultaneously. This is certainly so in the case of a large stick-insect<sup>2</sup> common near Kurseong in the rains. The union continues for several days on end, perhaps longer; and eggs are protruded from an aperture ventral to that occupied by the penis of the male.

### Mantidae.

Anderson (*Proc. A.S.B.*, 1877, pp. 193-5) and Willey (*Spolia Zeylanica*, II, pp. 198-9, 2 pl.) describe the floral simulation of *Gongylus gongylodes*. Willey (*Spolia Zeylanica*, III, pp. 226-7) describes the stridulation of this species, and an account of its development has been published by Williams (*Trans. Ent. Soc. London*, 1904, pp. 125-137). Annandale (*Proc. Zool. Soc. London*, 1900, pp. 839-854, 2 text-figs.) gives an account of the habits of the flower-mimicing *Hymenopus bicornis* and of other Malayan species.

Browne (*J.B.N.H.S.*, XII, pp. 578-9) records the killing of a sunbird, *Arachnechthra minima*, by a large mantis, "probably *Hierodula bipapilla*." An immature specimen of a large green mantis was recently sent to the Indian Museum by Mr. Matilal Ganguli, who had found it surrounded by six or seven sparrows that were attempting to kill it. When they tried to peck at it, it ran very fast towards the assailants, making darts at them which caused them to withdraw. The struggle was still in progress when the specimen was captured.

The food of mantises, with an account of the gradual eating of the male of an American species by the female during and without interfering with copulation is described by Mosse (*J.B.N.H.S.*, XX, pp. 878-9) and Coleman (*J.B.N.H.S.*, XX, pp. 1167-8). I have seen newly hatched young of a big green mantis feeding on minute Chloropid flies (*Pachylophus adjacens*, Brun., MS.) on a bush of *Zizyphus jujuba* on the Calcutta maidan—a bush which always attracts these flies during the rains, when they sit about on its leaves in large numbers.

### Acridiidae.

Alcock (*J.A.S.B.*, LXV [II], pp. 539-540; reprinted *J.B.N.H.S.*, XI, pp. 149-150) records the behaviour of a bear towards *Aularches*

<sup>1</sup> Concerning parthenogenesis in Phasmidae see also Hanitsch, *J. Straits R. Asiatic Soc.*, July 1904, pp. 35-38 (*Eurycnema herculanea*). Fryer records polymorphism in a Ceylon stick-insect (*Journal of Genetics*, III, pp. 107-111, pl. iii).

<sup>2</sup> Belonging apparently to the subfamily Lonchodinae. The female is a very heavily built stick-insect, the male more moderately stout.



*miliaris* (Linn.) as an instance of the natural repellent effect of "warning colours." This species when irritated, besides exuding a pungent-smelling frothy fluid, makes a curious hissing sound. Precisely how it does so I have been unable to determine. Legs and wings commonly vibrate synchronously with the production of this sound when the insect is held by the body; but when any or all of these appendages are prevented from moving the sound may still be produced, though the insect is usually less readily disposed to produce it under these conditions. There is no perceptible vibration of the body wall such as occurs when a fly or wasp buzzes. The breeding and other habits of this locust are described by Green (*Cir. R. Bot. Gardens, Ceylon*, III, pp. 227-235).

The "terrifying attitude" assumed by a grasshopper (*Acridium violascens*) when attacked by a myna (*Acridotheres tristis*) is described by Manders (*Spolia Zeylanica*, VII, pp. 204-5).

Kershaw gives a note on the habits and development of a Chinese "*Mastax* or *Eumastax*" (*J.B.N.H.S.*, XXII, pp. 416-7, pl. B, part).

Mr. Fletcher informs me that when he was in Coorg last year he found an Acridiid eating a large spider, a curious reversal of the normal course of events.

Cotes and others between 1890 and 1907 contributed a series of notes to the Journal of the Bombay Natural History Society, many of them of considerable length, on the habits, and especially on the migrations, of Indian locusts.

### Locustidae.

Green has described the stridulation of the common green locustid of Peradeniya (*Spolia Zeylanica*, VII, p. 56). A very similar but slightly stouter insect occurs in Calcutta. It has a different note, which has been described by Cunningham ("*Plagues and Pleasures*", p. 171). This note is, however, not unlike the last syllable of the Peradeniya insect, though somewhat harsher and less prolonged. When the insect is in full song in the open a distinct click is audible alternating with the somewhat rapid succession of these notes. *Mecopoda elongata* has a somewhat similar note which it repeats indefinitely in a similar manner, but this note is louder and still more raucous. All three of these insects are nocturnal.

Concerning the habitual attitude assumed by *Sathrophyllia rugosa* ("*Acanthodis uhulina*") see Willey (*Spolia Zeylanica*, II, p. 199, 1 fig.) and Annandale (*Mem. A.S.B.*, I, p. 209).

Green (*Spolia Zeylanica*, VI, pp. 134-5) has described the habits of a leaf-rolling species of *Gryllacris*, presumably a close ally of, if not identical with, a species—*Gryllacris aequalis*—found in the Calcutta Botanical Gardens by Wood-Mason (see Griffini, *Atti. Soc. Ital. Sci. Nat.* LII pp. 237-239, where references to other nest-

making Orthoptera will be found<sup>1</sup>). Gryllacrids are also sometimes to be found in holes in trees, under loose bark, and under the eaves of buildings.

Annandale and Gravely have described the habits of the Stenopelmatinae found in Burmese and Malay caves (*J.A.S.B.* [n.s.], IX, p. 413). In the Cochin Ghats Stenopelmatids are common under logs of wood.

Alarming colour and attitude in *Capnoptera*, spp., and a possible use of the spines on the thorax of *Eumegalodon blanchardi*, are described by Annandale (*Proc. Zool. Soc., London*, 1900, pp. 854-5 and 866).

### Gryllidae.

The habits of a noisy burrowing cricket—doubtless *Brachytrypes portentosus* ("achatinus"<sup>2</sup>)—are described at length by Cunningham ("Plagues and Pleasures," pp. 161-170). I have never seen "molehill-like heaps of loose earth cast out of the mouths of almost finished diggings" of these crickets. Sometimes there is a small and untidy collection of loose earth, but I have usually found the burrows somewhat difficult to locate in spite of the vigour with which the insects proclaim their whereabouts.<sup>3</sup>

A cricket closely resembling *Brachytrypes achatinus*, but much smaller, often flies to light in Calcutta. Like many still smaller species it has a way of partly unfolding its wings and then rapidly vibrating them. Why it should do this I have been unable to determine. The action, which is performed equally by both sexes, looks like stridulation, but only the faintest rustling sound is produced, and the male stridulates loudly in the ordinary way.

Mr. Fletcher tells me that *Liogryllus bimaculatus* is neither exclusively vegetarian nor exclusively carnivorous, feeding on both vegetable matter and dead insects when both are offered.

Nothing yet appears to have been recorded of the Calcutta house-cricket. It is a fair-sized, mottled, grey-brown insect, flightless in both sexes. The female is entirely wingless, but the male has well-developed elytra provided with a stridulating organ of the usual Gryllid type, with the aid of which he sings even more persistently, though fortunately more quietly, than *Brachytrypes portentosus*, going on from evening far into the night. This familiar song is, however, not the only one that he is capable of pro-

<sup>1</sup> See also Rutherford, *Spolia Zeylanica*, X, p. 77.

<sup>2</sup> For synonymy see Kirby's "*Synonymic Catalogue*" (British Museum).

<sup>3</sup> Mr. Bainbrigge Fletcher tells me that most of the burrowing is done before the insect becomes mature and begins to sing. Concerning the singing he says "The male first looks out of its burrow, then runs out rapidly and retreats again as quickly, having apparently brought up a little earth; sometimes it repeats this two or three times. Satisfied that the coast is clear, the cricket runs boldly out onto the little platform of earth outside its burrow, turns round facing its hole and with its head almost in the entrance, raises itself on its legs which are well spread out, slightly opens out its tegmina and commences to shrill. A slight quivering of the tegmina is all that can be seen, the motion apparently being too rapid for the eye to follow."

ducing; and when courting a female he changes it for a low whirring sound accompanied at regular short intervals by an abrupt squeak.

The first occasion on which I heard this was early in the rains of last year. I had three or four adult males in a glass jar. They stridulated as usual till I chanced to catch a couple of females which I put with them, when a change in their behaviour was at once apparent. First one and then another would approach one of the females and commence his courting notes, vibrating his elytra to produce the continuous whirring sound to all appearance just as when producing his ordinary song, but giving them periodic jerks which synchronized with the sudden squeaks. And this in spite of the fact that the females were all in their penultimate stage, and so failed to respond to any advances.

Some time later I heard these peculiar notes under different circumstances. On entering my office on a holiday, when the room was quite quiet, I heard what I at first took to be the squeaking of an electric fan. But it came from a direction where there were no fans, and on following it up I became aware of a low whirring sound accompanying it which suggested that I might be on the track of a pair of crickets, courting under natural conditions, although it was still early in the afternoon. The noise was located in a narrow covered space open at both ends, and on inserting a stick at one end a pair of common house-crickets soon appeared at the other. Unfortunately one of them escaped, so I was unable to make further observations upon them.

On another occasion, when attracted by the normal note of a male, I found him to be accompanied by a female to whose posterior end a small white body—presumably a spermatophore—was attached. So it may be customary for the male to entertain his mate for a time with his normal song after the pairing is over. Shortly afterwards I saw the female put her head between her legs, seize the spermatophore in her jaws and devour it. She was in a jar with several males, and I chanced to notice during the next morning that another spermatophore had been attached. This disappeared soon after, but I do not know how.<sup>1</sup>

### EMBIOPTERA.

The first Indian Embiid whose habits appear to have attracted any attention was *Oligotoma michaeli*, of which specimens were transported from India to England in orchid roots, among which they lived in silken tunnels, and to which they proved destructive (see Michael in *Gardener's Chronicle*, Dec. 30, 1876 and M'Lachlan *J. Linn. Soc. London, Zool.* XIII, pp. 373-384, pl. xxi). The first observations made in India appear to be those of Wood-Mason on

<sup>1</sup> Changes in the notes of American locusts, and their association with courtship, are noted by Allard (*Ent. News*, XXV, 1914, pp. 463-466). They have, I believe, been noted in other Orthoptera saltatoria also, but I do not know where the observations have appeared.

*Oligotoma saundersi* published in 1883 (*Proc. Zool. Soc. London*, pp. 628-634, pl. lvi). Lefroy published a short note on this species in 1910 (*J.B.N.H.S.*, XIX, pp. 1009-1010). In 1911 Imms published an account of the habits and life-history of *Embia major* (*Trans. Linn. Soc. London, Zool.* XI, pp. 167-195, text-figs. 1-6, pl. xxxvi-xxxviii.)

### ISOPTERA.<sup>1</sup>

A brief note on the tapping noises made in unison by termites was published by Fedden (*Proc. A.S.B.* 1866, p. 19). A paper by Bugnion (*Bull. Soc. Ent. Suisse*, XII, Berne 1912, pp. 125-139, pl. ix) deals with the same subject. These noises were frequently heard last year on some trellis-work in the Indian Museum compound, though I failed to notice any rhythmic unison in their production. The trellis was covered with the mud shelters of termites, and when approached or tapped myriads of faint clickings were clearly audible. The sound at first suggested the cracking of the mud; but it was to be heard in the morning before the sun fell on the trellis (which faced west) as well as in the evening. If, moreover, the mud were broken away while the clicking was in progress, termites were always found beneath; whereas if the disturbance causing the clicking were kept up for a few minutes the clicking would cease, and then no termites would be found. This clicking is of course quite different from the clicking of *Capritermes*, which appears to be produced by the combined action of the remarkable jaws of the soldier, and sounds like the sudden cracking of a piece of thin glass. The force expended by *Capritermes* in producing it often flicks the producer up into the air.

A note on the repairing of a damaged termite nest was published by Millett in 1902 (*J.B.N.H.S.*, XIV, pp. 581-2), and one on strange mortality of termites among tea bushes by Green in 1905 (*J.B.N.H.S.*, XVI, pp. 503-4). Doflein, in his paper on termite truffles published in the same year (*Ver. Deutschen Zool. Ges.*, XV, pp. 140-149, 2 text-figs.; translated, *Spolia Zeylanica* III, pp. 203-9), notices the food of termites. In 1906 Petch noticed the habits of some Ceylon termites in his paper on the fungi of certain termite nests (*Ann. R. Bot. Gard., Peradeniya*, III, pp. 185-270, pl. v-xxi). Green in 1907 recorded the occurrence of two queen termites in one royal cell (*Spolia Zeylanica*, IV, p. 191). Escherich's "*Termitenleben aus Ceylon*" (Jena, 1911) deals extensively with habits. In 1913 Assmuth described the habits of many species of termites in his paper on "Wood-Destroying Termites of the Bombay Presidency" (*J.B. N.H.S.*, XXII, pp. 372-384, pl. i-v), and Petch described those of *Eutermes monoceros*, the black termite of Ceylon (*Ann. R. Bot. Gard., Peradeniya*, V, pp. 395-420, pl. vi-xiv). During the same year Green's "Catalogue of Isoptera recorded from Ceylon" (*Spolia Zeylanica*, IX,

<sup>1</sup> See also Escherich, "Die Termiten" (Leipzig 1909); and Wasmann's "Neue Beiträge zur Kenntnis der Termitophilen und Myrmecophilen", *Zeitschr. wiss. zool.* CL, 1912, pp. 70-115, pl. v-vii.



pp. 7-15), and John's "Notes on some Termites from Ceylon" (*Spolia Zeylanica*, IX, pp. 102-116) were published, and in both the habits of a number of species are referred to. The most recent paper on the habits of Ceylon Termites appears to be by Bugnion<sup>1</sup> (*Bull. Mus. Hist. Nat. Paris*, 1914, no. 4, pp. 3-37, pl. i-viii).

Termites usually "swarm" in the rains; but in some species at least winged adults are ready to emerge even in the cold weather, and need only the stimulus of rain to bring them out. The cold weather of 1914-5 was remarkable in Calcutta for several periods of exceptionally damp and chilly weather. On each occasion numbers of termites were seen flying above the Maidan. On one occasion (16-i-15) I found a dense swarm emerging from a nest and collected specimens, which have been identified by Mr. Fletcher as a species of *Odontotermes*, probably new.

### PSOCOPTERA.

Green describes the habits of Scaly-Winged Psocids (*Spolia Zeylanica*, IV, pp. 123-125) and of Psocids which combine to spin extensive webs on trees (*Spolia Zeylanica*, VIII, 1912, p. 71, 1 pl., 2 text-figs.).

The habits of Psocids, and the occurrence of fatal epidemics among gregarious species, are referred to by Cunningham ("Plagues and Pleasures", pp. 151-5).

### ODONATA.

Observations on the food of dragonflies have been recorded by Young (*J.B.N.H.S.*, XV, p. 530), Lefroy (*J.B.N.H.S.*, XX, pp. 236-8), Fulton (*J.B.N.H.S.*, XX, p. 876), and Green (who publishes information supplied him by Mr. John Pole, *Spolia Zeylanica*, VIII, p. 299). The oviposition of dragonflies is described by Cunningham ("Plagues and Pleasures", pp. 133-5). The vitality of dragonfly larvae out of water form the subject of a note by Green (*Spolia Zeylanica*, V, pp. 104-105).

### NEUROPTERA (s. str.).

Annandale notices the habits of an Indian *Sisyra* larva (*J.A.S.B.* [n.s.], II, pp. 194-5, pl. i, fig. 3).<sup>2</sup>

<sup>1</sup> Other papers by this author are scattered in various journals. The following list of those dealing to some extent with the habits of Oriental Termites is compiled from reprints sent to Mr. T. Bainbrigge Fletcher:—"Le Termite noir de Ceylan", *Ann. Soc. Ent. Fr.* 1909, pp. 271-281, pl. viii-x; another paper with the same title, *Bull. Soc. Vaud. Sci. Nat.*, XLVII (173), pp. 417-437, figs. 1-5; "Observations relatives à l'Industrie des Termites", *Ann. Soc. Ent. Fr.*, 1910, pp. 129-144; "*Eutermes lacustris*, nov. sp. de Ceylan", *Rev. Suisse Zool.*, XX, 1912, pp. 487-505, 1 text-fig., pl. vii-viii; "*Le Termes Horni*", Wasm. de Ceylan, *Rev. Suisse Zool.*, XXI, 1913, pp. 299-330, 1 text-fig., pl. xi-xiii; "Les Termites de Ceylan", *Le Globe, Organe Soc. Geogr. Genève*, LII, 1913, pp. 2-36, pl. i-viii.

<sup>2</sup> Not fig. 2 as stated in the text of the paper. This probably represents the larva of a Trichopteron, not a beetle.

The habits of Myrmeleonid and Ascalaphid larvae from tree-trunks are described by Gravely and Maulik (*Rec. Ind. Mus.*, VI, pp. 101-3, pl. v). Perhaps the "ant-lion" which Ryves found dead in a spider's web in a mango tree (*J.B.N.H.S.*, X, pp. 152-3) belonged to a species with similar habits.

The life-history of *Helicomitus dicax* is described by Ghosh (*J.B.N.H.S.*, XXII, pp. 643-8, 1 pl.). The larva of this Ascalaphid lives on the ground and covers itself with dust.

"The Indian Nemopterid and its food" is the title of a note by Lefroy on the larva of *Croce filipennis* (*J.B.N.H.S.*, XIX, pp. 1005-7, 1 text-fig.). Further studies on *Croce* have since been published by Ghosh (*J.B.N.H.S.*, XX, pp. 530-532, 1 pl.) and Imms (*Trans. Linn. Soc. London, Zool.* XI, pp. 151-160, pl. xxxii).

## TRICHOPTERA.

A viviparous caddis-fly is described by Wood-Mason under the provisional name *Notanatolica vivipara* (*Ann. Mag. Nat. Hist.* [6], VI, pp. 139-141, text-figs. a-b).

## HYMENOPTERA.

### Miscellaneous.

The habits of various Indian Hymenoptera are very briefly referred to by Wroughton (*J.B.N.H.S.*, IV, pp. 26-37). The habits of a number of Indian Aculeata are described by Dutt (*Mem. Dept. Agric. India, Entom. Ser.* IV, pp. 183-267, pl. xi-xiv, 22 text-figs.).<sup>1</sup>

### Chalcidae.

Cunningham devotes the third chapter of, and an appendix to, his "*Plagues and Pleasures of Life in Bengal*" to fig-insects. The particular insects whose habits are described are those which are associated with *Ficus roxburghii* in Calcutta, and his observations are clearly the result of his work on the fertilization—if such it may be called—of this fig by these insects (*Ann. R. Bot. Gardens, Calcutta*, I, Appendix 2, 1889, 37 pp., 5 pl.).

The habits of *Syntomosphyrum indicum* are described by Silvestri in *Div. Ent., Hawaii Board Agric. and For.*, No. 3, pp. 125-127.

### Ichneumonidae.

Ramsay describes the oviposition of a species of *Rhyssa*—probably a species found in the Himalayas (*Entomologist*, XLVII, pp. 20-22, 3 text-figs.).

### Braconidae.

A note on a species of *Apanteles* parasitic in the caterpillar of a Death's Head Moth has been published by Green in *Spolia Zeylanica*, V, p. 19, 1 pl.

<sup>1</sup> A note on the capture of a leaf-mining caterpillar by a wasp is contributed by Ridley to *J. Straits R.A.S.*, July 1905, pp. 227-8.

### Chrysidæ.

Bingham refers to the habits of *Chrysis fuscipennis* in *J.B.N.H.S.*, XII, p. 586, Cretin to those of *Stilbum splendidum*, *J.B.N.H.S.*, XIV, pp. 823-4.

### Mutillidæ.

Wroughton refers to the habits of an Indian Mutillid (*J.B.N.H.S.*, VI, p. 118).

### Pompiliidæ.

The food of several members of this family is recorded by Bingham, who also describes the capture of a Galeodid by *Salix sycophanta* (*J.B.N.H.S.*, XIII, pp. 178-180).

### Sphegidæ.

Bingham mentions the food of several species of Sphegidæ, and a remarkable concentration of the nests of a variety of *Sphex umbrosus* (*J.B.N.H.S.*, XIII, pp. 177-8).

Notes on the habits and food of *Sphex lobatus* are contributed by Lefroy (*J.B.N.H.S.*, XV, pp. 531-2), and by Beadnell (*J.B.N.H.S.*, XVII, p. 546).

Wickwar describes the habits of *Sceliphron violaceum* (*Spolia Zeylanica*, VI, p. 179), Cory those of *S. intrudens* (*J.B.N.H.S.*, XXII, p. 648), and Field those of *S. coromandelicum* (*J.B.N.H.S.*, XXIII, pp. 378-9).

### Eumenidæ.

Concerning *Eumenes conica* see Bingham (*J.B.N.H.S.*, XII, pp. 585-6), and Ramakrishna Aiyer (*J.B.N.H.S.*, XX, pp. 243-4). The former author deals with the construction of the nest and with pugnacity displayed towards a parasitic *Chrysis*, and the latter with breeding habits and development.

For notes on *Eumenes dimidiatipennis* see Cretin, *J.B.N.H.S.*, XIV, pp. 820-824.

*Odynerus punctum* is recorded as cleaning out and using empty cells of *Eumenes dimidiatipennis* (Cretin, *J.B.N.H.S.*, XIV, p. 824).

### Vespidae.

Battles between wasps and bees are recorded by Hewett (*J.B.N.H.S.*, IV, p. 312) and by Driberg (*Spolia Zeylanica*, IV, p. 33). In the former case the wasps were *Vespa magnifica* and the bees "the large jungle bees" (? *Apis dorsata*). A battle between two kinds of wasp, apparently *Vespa cincta* and *Polistes hebraeus*, is recorded by Cunningham ("Plagues and Pleasures", p. 31). The habits of the former wasp are dealt with on pp. 29-33 of the same book, and of the latter on pp. 23-28. Mr. Fletcher has given me the following additional note on this subject: "Last

July, when travelling by train, a specimen of *Vespa cincta* flew into the carriage carrying a *Polistes hebraeus* which it had captured. *V. cincta* and various other large *Vespa* spp. are determined captors of honey-bees as these enter or leave the hive."

The capture of a small Pyralid moth by *Vespa cincta* is recorded by Green (*Spolia Zeylanica*, II, p. 197).

### Apidae.

In addition to the notes just referred to recording battles between wasps and bees, the following references to bees may be given.

Douglas contributes information about the hive-bees indigenous to India and the introduction of the Italian bee (*J.A.S.B.*, LV [II], pp. 83-96).

Storey records the poisonous action of the nectar of *Lapindus emarginatus* on bees (*J.B.N.H.S.*, V, p. 423).

Eardley-Wilmot refers to an instance of a man who, having disturbed a bees' nest, was attacked by its inhabitants, and later in the day was singled out from his companions for attack by bees from other nests which he chanced to approach (*J.B.N.H.S.*, XI, pp. 741-2).

Bingham describes the habits of *Megachile disjuncta* and its parasite *Paravaspis abdominalis* (*J.B.N.H.S.*, XII, p. 587).

Several parasites from the nests of *Xylocopa tenuiscapa* have been recorded by Green (*Ent. Mo. Mag.* [2], XIII, pp. 232-3). In an article in *Spolia Zeylanica* (I, pp. 117-9) on the mites which inhabit the remarkable abdominal pouch of this species, references to two other papers dealing with these mites are given. These are Perkins, *Ent. Mo. Mag.*, [2], X, pp. 37-9; and Oudemans, *Zool. Anz.*, XXVII, pp. 137-9. The latter contains further references.

A note on the effects of the sting of *Xylocopa tenuiscapa* is contributed by Green (*Spolia Zeylanica*, VI, p. 134).

Notes on the habits of *Apis dorsata* are contributed by Willey (*Spolia Zeylanica*, VI, p. 181, 1 pl.).

The characteristic odour of leaf-cutting bees is described by Green (*Spolia Zeylanica*, VII, p. 55).

Castets contributes an article entitled "Les Abeilles du sud de l'Inde" to the *Revue des Questions Scientifiques* (Brussels, Oct. 1893). He deals with the habits of the three Indian species of *Apis* and of *Mellipona iridipennis*. An abstract of this article will be found in the *Tropical Agriculturalist* (XXX, 1908, pp. 48-54).

The peculiar way in which a bee "painted in alternate bands of shining black and the brightest, purest cobalt"—doubtless an *Anthophora*—collects pollen, and its way of resting for the night, are described by Cunningham ("Plagues and Pleasures", pp. 37-8).

The burrows of *Anthophora* (or *Podalirius*) *pulcherrima* are described by Annandale (*Rec. Ind. Mus.*, III, p. 294, 1 text-fig.), who notes that they open in a direction which prevents rain from entering them to any great extent.



### Formicidae.

The habits of a number of different species are referred to by Rothney (*Trans. Ent. Soc. London*, 1889, pp. 347-374 ; reprinted *J.B.N.H.S.*, V, pp. 38-64), Wroughton, (*J.B.N.H.S.*, VII, pp. 13-60 and 175-202, pl. A-D), and Cunningham (" *Plagues and Pleasures*", pp. 40-54).

The care of Lycaenid larvae by ants is described by de Niceville (*J.B.N.H.S.*, III, pp. 164-8, pl. 26-7).

Bingham contributes a note on the habits of *Diacamma* (*J.B.N.H.S.*, XII, pp. 756-7).

Green describes the web-spinning of *Oecophylla smaragdina* (*Proc. Ent. Soc. London*, 1896, p. ix and *J.B.N.H.S.*, XIII, p. 181). Some earlier papers on this subject, and the fact that *Oecophylla smaragdina* does not spin a cocoon in which to pupate, are noticed by Green (*Spolia Zeylanica*, I, pp. 73-4), and the matter forms the subject of notes by Fletcher (*Spolia Zeylanica*, V, p. 64), Ridley (*J. Straits R. Asiatic Soc.* No. 22, Dec. 1890, pp. 345-7) and Shelford (*J. Straits R. Asiatic Soc.* June 1906, pp. 284-5).

A living chain of *Oecophylla smaragdina* spanning a gap of 3 inches is described by Green (*Spolia Zeylanica*, VII, pp. 53-4). The capture of a living butterfly (*Catopsilia crocale*) by this species is recorded by Henry (*Spolia Zeylanica*, IX, pp. 142-3). A lengthy note on the habits of the same species in the Malay Peninsula will be found in *Fasciculi Malayenses*, Zool. III, pp. 27-30.

A remarkable illustration of the very large quantities of grain carried away and stored by ants is given by Fraser (*J.B.N.H.S.*, XX, p. 877).

The carrying away of a partially disabled caterpillar by a party of ants is described by Sladen (*J.B.N.H.S.*, XXII, p. 649).

## COLEOPTERA.<sup>1</sup>

### Passalidae.

I have already once gathered together as much information as I could obtain about the habits of Indian Passalidae (see *Mem. Ind. Mus.*, III, pp. 339-340). Since then Mr. T. Bainbrigge Fletcher has taken *Episphenus neelgherriensis* at light in Coorg, and has obtained eggs of *Macrolinus rotundifrons* from under a log at Peradeniya where they were found "in a circular chamber partly filled with gnawed wood." In view of the suggestion made in the "*Fauna of British India*" (Lamellicornia, I, p. 20) that the Passalidae are a viviparous family the latter observation is of great interest. It may not be out of place to note here that when, during my visit to Berlin in 1913, I called the attention of Dr. Ohaus to the suggestion, he immediately refuted it by the production of eggs of American species preserved in his fine private collection.

<sup>1</sup> Concerning stridulation in this Order, with which several of the following notes are concerned, see Gahan, *Trans. Ent. Soc. London*, 1900, pp. 433-452, pl. vii ; and Arrow, *Trans. Ent. Soc., London*, 1904, pp. 709-750, pl. xxxvi.

My suggestion (*Mem. Ind. Mus.*, III, p. 215) that *Pleurarius brachyphyllus* is probably not a gregarious species has proved to be incorrect. This species is abundant in the evergreen jungles of the lower western slopes of the Western Ghats in Cochin. Occasionally isolated pairs were found in a log, but usually numbers were found together. It is scarcely possible that insects of this species are able to fly; for although the wings are well developed the elytra are fused. How this fusion takes place I was unable to determine, as only one pupa was found, and no stages intermediate between this and the almost fully blackened adult. The elytra are not fused in the pupa.

The conclusion that *Epispheenus indicus* is to some extent gregarious, and that *E. neelgherriensis* is not, was confirmed by my observations in Cochin. All of the three last mentioned species burrow more deeply into logs than does *Leptaulax bicolor* which, together with its larvae and pupae, was only found close under the bark. *Pleurarius brachyphyllus*, especially, makes galleries well below the surface, a fact which probably accounts for its comparative rarity in the collections I had previously seen. It often burrows in somewhat hard wood and is very difficult to dig out; but I found it even commoner in Cochin than *Epispheenus indicus*, a species which was distinctly commoner than *E. neelgherriensis*.

The larvae of *Pleurarius brachyphyllus* and *Epispheenus indicus*—I got very few of *Epispheenus neelgherriensis* and *Leptaulax bicolor*—were commonly found widely separated from adults. In some cases no adults at all could be found, and it is curious, in view of Ohaus's observations on American species, that although all the larvae which I attempted to keep thrived for a time, whether associated with adults or not, only those without adults survived the journey to Calcutta; and that of these one or two lived for between one and two months. I regret now that I did not make an effort to keep single families by themselves. This was, however, rendered almost impossible, firstly by the difficulty of recognizing a single family as it occurred scattered along one or more of the groups of burrows made by the various members of the colony, and secondly by an insufficient supply of separate tins.

Stridulation in adults of both *Epispheenus* and *Pleurarius* is brought about by movements of the abdomen, and is faintly audible at a yard or two's distance from the ear. In larvae it is much fainter. I never saw any indication of its being used as a means of communication, and this agrees with Mr. Kemp's experience of species found in the Abor Country. Adults, at least, appear to stridulate whenever they are disturbed, presumably in order to drive off the enemy.

The stridulating organs resemble those of *Popilius* (*Passalus*, auct.) *cornutus* and *Pentalobus barbatus*<sup>1</sup> described by Babb (*Ent.*

<sup>1</sup> The abdominal part resembles that of *Proculus goryi* also; but the wings are not reduced as in that species. I cannot understand Schulze's statement that in *P. goryi* the abdominal part is situated on the fifth segment, for his figure (in which the first segment is omitted) clearly shows it on the sixth, where it is

*News*, XII, p. 271<sup>1</sup>) and Schulze (*Zool. Anz.*, XL, pp. 209-216, figs. 5-7). The organs to which Ohaus attributed stridulatory functions (*Stettin Ent. Zeit.* 1900, pp. 167-169) are also well developed. In a footnote to the first page of Schulze's paper Ohaus says, "Was die von mir l. c. beschriebene Bildung für eine Bedeutung hat, ist bis jetzt noch nicht festgestellt. Sie findet sich bei den meisten, vielleicht allen, holzbewohnenden Lamellicorniern und hat vielleicht den Zweck, das Eindringen von Wasser, vielleicht auch von Schmarotzern, in die Räume zwischen den Tergiten und Flügeln zu verhindern. Speziell die Passaliden sind an den Rändern der Tergite häufig mit Milben besetzt."

In order to test the possible stridulating powers of the two sets of organs I removed the wings of a *Pleurarius*. Although the abdomen subsequently moved as if trying to stridulate no sound was produced. A good deal of fluid escaped, however, from the places where the wings had been inserted, which might have affected the vibrations; so I then cut off the ends of the wings of another specimen of the same species. Its abdomen moved vigorously but only a very faint sound was produced, a sound which I attribute to a small portion of the stridulating surface of the wing having escaped removal. I then took a specimen of *Episphenus indicus*, in which the elytra are not fused and can consequently be opened, and found that so long as the folded wings were pressed down on to the abdomen by a needle the insect could stridulate as well as before, even though the elytra were held right away from the sides of the abdomen.

I have never heard any Passalid emit notes of more than one kind, and all have been fainter than those produced artificially by rubbing the end of the wing of a softened specimen of *Proculus goryi* on the plate beneath it.

### Lucanidae.

*Nigidius dawnae* lives in hard dry pieces of wood on the higher slopes of the Dawna Hills. Both adults and larvae were found in one such piece (see *Rec. Ind. Mus.*, XI, pp. 427-429). Mr. Kemp informs me that *N. impressicollis* lives, in both the larval and adult condition, in thoroughly damp and rotten wood. Mr. Beeson informs me that *N. distinctus*<sup>2</sup> lives in dead wood of Malatta (*Macaranga pustulata*) in the Duars.

### Dynastinae.<sup>3</sup>

The stridulating ability of *Xylotrupes gideon* has been recorded by Cunningham ("Plagues and Pleasures", pp. 126-7, pl. ii,

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situated in the specimen of *P. goryi* that I have examined, and also in *Pentalobus barbatus*, *Pleurarius brachyphyllus*, etc.

<sup>1</sup> See also Sharp, *Ent. Mo. Mag.* (2) XV (X1), 1904, pp. 273-4.

<sup>2</sup> Concerning the identity of this species see *Rec. Ind. Mus.*, XI, p. 430.

<sup>3</sup> Attention may be called here to the occurrence, in a paper on Paussidae,

fig. 5; quoted in *Fauna of British India*, Lamellicornia, I, p. 265).<sup>1</sup>

Concerning the action of the stridulating organs of *Oryctes rhinoceros* nothing yet seems to have been published. I have had great difficulty in obtaining any evidence as to the use of the so-called stridulating organ found in the larva (pl. xxii, fig. 1). When a specimen is tightly held by the head, however, it may be seen to move the mandibles and maxillae in a manner likely to bring the organ into action, and a faint rasping sound may sometimes be heard if the specimen be brought close to the ear. No definite vibrations have been felt, and the movements of the mandibles and maxillae are those which would probably be used, in order to free itself, by any insect similarly placed. Pressure on the body does not seem to induce any such movements, but they are sometimes indulged in by larvae which find themselves on their backs on a hard surface in the open. The movements are often greater in extent than their use for stridulatory purposes requires; the mandibular part of the organ is, indeed, sometimes fully exposed at intervals, and could not then be scraped at all by the maxillary portion. The rasping seems, nevertheless, to be produced only when these movements occur. It is therefore probable that it is produced by the organs in question, and it is noteworthy that the movement of the mandibles and maxillae is often very small—as it should be to keep the two parts of the organ in contact—and that this does not interfere with the sound produced.

The pupa, in which no stridulating organs appear to have been described, stridulates quite audibly when disturbed. The sounds are produced as the result of backward and forward movements of the abdomen, movements which cause a pair of scrapers situated on the dorsal part of the anterior margins of segments 2-6 to rub over the faintly ridged surface of the hard chitinous walls of oval depressions on the posterior parts of segments 1-5 (pl. xxii, figs. 2-3), producing vibrations through the whole pupa, as well as sound. The organs are very conspicuous in living specimens, but in preserved ones they are apt to be largely hidden between the terga. The organ between segments 6 and 7 is rudimentary.<sup>2</sup>

I have heard the adult stridulate, but not loudly. The sound appears to be produced by the rubbing of the well-known ridges on the posterior end of the abdomen against the posterior ends of the elytra (pl. xxii, fig. 4), but I have not yet been able to investigate this as fully as I would like.

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where it is most unlikely to attract the attention of those interested (*F.A.S.B.*, XII, pp. 421-437), of a coloured figure of *Eupatorus hardwickei* from the summit of the Gogur Range, 9000 ft., in Kumaon.

<sup>1</sup> See also Rutherford, *Spolia Zeylanica*, X, p. 77.

<sup>2</sup> Similar structures are present in the pupae of several other beetles—e.g. *Adoretus* (Rutelinae) and *Hectarthrum* (Cucujidae)—but they do not appear to be stridulatory on any segments in them.



### Rutelinae.

Leaves of *Lagerstroemia* bushes in the Indian Museum compound are frequently eaten extensively by a nocturnal insect, and by searching among them after dark a few Melalonthids and a large number of Rutelids have been obtained. All of the latter belong to the genus *Adoretus*, and Mr. Arrow has identified almost all of them as *A. versutus*. Occasional specimens have been found feeding on *Bauhinia*, *Canna*, and a leguminous shrub (? *Cassia*); but they are found in much greater abundance on *Lagerstroemia* than on anything else.<sup>1</sup>

Mr. Arrow informs me that nothing is yet known of the manner of feeding in this genus, and I have been able to make the following observations.

At night, after emerging from the ground in which it has been buried all day and to which it returns before morning, the beetle flies to a leaf, and settles either on the upper or under side, usually the latter. It never settles on the edge. The claws of two or three tarsi, often all on the same side of the insect, grasp the edge; the others rest on the surface.

In beetles of this genus, the mouth is divided into two by a median process of the labrum (pl. xxii, fig. 5). When the insect wishes to take a bite, therefore, it turns its head slightly on one side; and although the mouth-parts of both sides work simultaneously, the bite is effected by those of one side only.

The strongly toothed extremity of the maxilla forms the principal biting organ. When a specimen begins to feed both mandibles and maxillae are opened widely. Then the maxillae are exerted between the mandibles and the median process of the labrum, the maxilla of whichever side of the head has been turned nearest the leaf scooping out a small quantity of the soft tissue of which the leaf is composed between the principal veins. This tissue does not appear to offer the slightest resistance to the maxilla, which seems to scoop it up as easily as if it were soft wax; and so far as I have been able to see the beetle makes no special effort to keep the leaf from being pushed away instead of cut into. I do not even think that the median process of the labrum is lowered against it, as I have been unable to see this organ during the process. Had it been lowered it must, I think, have come into view.

Three or four bites are required to make a hole right through the leaf, after which bigger bites can be made. The general method is the same, but the end of the maxilla is passed through the hole, and as far beyond the edge as it will go, so that it bites each time through the whole thickness of the leaf. Here again

<sup>1</sup> A few specimens of *A. duvauceli* have also been found on *Lagerstroemia* and of *A. lasiopygus* on *Hibiscus*. *A. versutus* has been found in great abundance on *Cannas* since the above was written, and its larvae and pupae have been found among their roots.

the tissues of the leaf appear to offer no resistance, but as the maxilla passes back into the cavity between the mandible and labral process close to the concave part of the serrate margin of the latter, there is probably some amount of scissor action between them.

The mandible closely follows the maxilla in all its movements, and forms a sheath above it. Precisely to what extent it functions as a biting organ is most difficult to see with certainty. Its smooth dorsal face works along the serrate transverse edge of the labrum from end to end, and its distal end slides past the serrate longitudinal edge of the labral process as it follows the maxilla into the cavity behind. Probably the mandible makes all the transverse cuts that are required, and it could no doubt make longitudinal cuts as well should the maxilla fail to work properly; but no transverse cutting seems to be left for it under ordinary circumstances, and the tracks of the maxillary teeth can be distinctly seen on each freshly bitten surface. One of the chief functions of the mandible appears to be to protect these teeth, when they are not in use, by closing in the cavity between the labrum and the labium, in which they lie when at rest.

Intervals of varying length between the bites are devoted to mastication. During this process the gnathites of the two sides work simultaneously as before, but the maxillae are not exerted—i.e. they remain in the cavity between the mandibles, their extremities being exposed between (and posterior to) the mandibles and the labral process each time they are opened. At the same time the labral process and labium are alternately separated a little and brought together again. Mastication presumably takes place chiefly between the large molar teeth, situated one at the base of each mandible (pl. xxii, fig. 6), the triangular thickened area on the inner side of the labium (pl. xxii, fig. 6), and the somewhat similar convexity on the inner side of the labrum. It is possible, however, that the terminal teeth of the maxilla take some part in it also, for those of opposite sides are not quite alike, and when pressed together after removal of the labrum, the teeth of one side may be seen to fit into the spaces between the teeth on the other, although the teeth can never be brought together thus during the process of biting.

This method of feeding differs in several respects from the method of feeding observed by Ohaus (*Stett. Ent. Zeit.*, 1909, pp. 12-13) in Rutelinae of the *Geniastes* group, South American insects whose mouth is also divided longitudinally into two parts. *Geniastes* and its allies always cling to both sides of the leaf at the same time instead of to one side only, commencing to feed at the edge instead of on the upper or under side; they also exude such large quantities of saliva that it escapes from the mouth and stains the bitten margin of the leaf—a thing which has never been observed in *Adoretus*.

The difference in the method of biting the leaf is associated with differences in the structure of the mouth parts. *Geniastes*

and its allies<sup>1</sup> are said to take the edge of a leaf in their mouths and cut a piece out by a scissor-like action between the mandibles and labrum and the maxillae and labium. The mandibles are likely, therefore, to have a very strongly developed cutting edge in front. This is the case in *Geniates impressicollis*, a species in which there is in addition a narrow posterior part, forming an imperfect sheath for the maxilla, at right angles to the cutting part. The cutting portion of the mandible of *Geniates* appears to be homologous with the greater part of the sheathing mandible of *Adoretus*. The maxillae of *Geniates impressicollis* are well developed, but are prismatic in form rather than scoop-like; they presumably aid in cutting only by dragging the leaf down over the sharp edge of the labium.

The mouthparts of *Leucothyreus trochantericus*, the only other species of the *Geniates* group that I have been able to examine, are more difficult to understand. The mandibles are so massive that it is difficult to see how the edge of a leaf is ever introduced into the mouth. Presumably, however, this must be the manner of feeding; for the species whose feeding habits were actually observed by Ohaus included some of the genus *Leucothyreus*. The maxillae are small and are not in any way sheathed by the mandibles, whose anterior edge appears to overlap the edge of the labrum when closed and so to be useless for cutting. Presumably the cutting is done by the leaf being dragged down across the edges of the labrum and labium by the main mass of the mandible, though even this is a little difficult to understand.

### Coprinae.

The stridulating habits of *Heliocopris mouhotus* are described by Annandale (*Fasciculi Malayenses*, Zool. I (II), p. 283).

Specimens of a somewhat smaller species of *Heliocopris*—probably *H. bucephalus*, Fabricius—sent to me by Mr. Bainbrigge Fletcher, stridulated loudly, but with the hind, not the middle, coxae. I failed to associate any form of stridulation with the middle coxae although these moved as freely as the others in life, and an exceedingly faint sound could be produced by moving them artificially after death. The front legs produced strong but inaudible vibrations, but whether in the coxal cavities or between the coxae and femora, I was unable to determine. I have been unable to reproduce these vibrations on dead insects.

### Cicindelidae.

Notes on the habits of a number of species are recorded by Annandale and Horn in the "*Annotated List of the Asiatic Beetles in the Collection of the Indian Museum*," Part I (Calcutta, 1909). The habits of some tiger-beetles from Orissa form the subject of a

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<sup>1</sup> *Leucothyreus* and *Bolax* appear to have been the actual genera observed (*loc. cit.*, pp. 18-21).

note by Gravely (*Rec. Ind. Mus.*, VII, pp. 207-9). In both places the habits of the littoral *Cicindela biramosa* are mentioned. An earlier communication with regard to this species was made by Fletcher (*Spolia Zeylanica*, V, pp. 62-3), who has recently published a note on tiger-beetles from Coorg (*J.B.N.H.S.*, XXIII, p. 379).

The breeding places of common Indian Cicindelidae have been discussed by Lefroy (*J.B.N.H.S.*, XIX, pp. 1008-9), and the life-history and habits of *Collyris emarginata* in the Sunda Islands by Koningsberger (*Med. 'Slands Plant.*, XLIV, p. 113, fig. 59) and Shelford (*J. Straits R. A. S.*, June 1906, pp. 283-4).

### Carabidae.

*Calosoma orientale* is recorded as an enemy of locusts by Cotes (*J.B.N.H.S.*, VI, p. 416).

### Paussidae.

Some Indian representatives of this family form the subject of a paper by Boyes, in which some account of their habits is given (*J.A.S.B.*, XII, pp. 421-437, 3 pl.).

### Malacodermidae.

The flashing in unison of swarms of fire-flies is discussed by Cameron, Clark, Fry and others (*Proc. Ent. Soc. London*, 1865, pp. 94-5 and 101-2, the former reprinted in *J.A.S.B.*, XXXIV [II], pp. 190-2); Theobald (*J.A.S.B.*, XXXV [II], pp. 73-4; reprinted *Proc. Ent. Soc. London*, 1866, pp. xxvii-xxviii); Fedden (*Proc. A.S.B.*, 1866, p. 19); Severn (*Nature*, XXIV, p. 165); Annandale (*Proc. Zool. Soc. London*, 1900, pp. 864-5); and Cunningham ("Plagues and Pleasures", pp. 129-130). I have only once seen an example of this phenomenon. I was walking after sunset near Dhammathat on the Gyaing River above Moulmein when I noticed that all the fire-flies of the neighbourhood seemed to have congregated round an isolated tree, and were flashing in unison with wonderful effect.

Aquatic fire-fly larvae are described by Annandale (*Proc. Zool. Soc. London*, 1900, pp. 862-4, and *J.A.S.B.* [n.s.], II, pp. 106-7).

Green notices the luminosity of *Harmatelia bilinea* and *Diophtoma adamsi* (*Trans. Ent. Soc. London*, 1912, pp. 717-719, and *Spolia Zeylanica*, VII, pp. 212-4, 1 pl.).

A glowworm with nine pairs of lights has been recorded from Ceylon by "M" (see *Proc. Ent. Soc. London*, 1865, p. 101).<sup>1</sup>

The large yellow-edged black larvae of *Lamprophorus tenebrosus* are luminous, but do not shine as brilliantly as do the mature females, which are uniformly yellowish in colour. The female may

<sup>1</sup> See also Rutherford, *Spolia Zeylanica*, X, pp. 72-74 (*Diophtoma adamsi*).



sometimes be found at dusk in vegetation by the road-side at Peradeniya, sitting curled up on the ground with the tail erected so as to expose her light to the best advantage. Males fly up with a loud buzzing sound, but without lights, and drop close to her. They then become faintly luminous and run round about her. When copulation takes place the female uncurls, and her lights die down till they give only a faint ventral glow. If the pair be separated the female lights up again at once. Males are often attracted to lights in houses, when they emit a steady bluish glow from the posterior part of the abdomen (see also Green, *Trans. Ent. Soc. London*, 1912, p. 719).

### Cleridae.

The habits and life-history of a Clerid near *Thanasimus nigricollis*, which is predaceous on Scolytidae, is described by Stebbing (*J.A.S.B.*, LXXII [11], pp. 104-110).<sup>1</sup>

### Anthicidae.

Ant-mimicry by a *Formicomus* is the subject of a note by Fletcher (*J.B.N.H.S.*, XXII, p. 415).

### Meloidae.

Blistering powers are recorded in *Cantharis rouxi* by Coleman (*J.B.N.H.S.*, XX, pp. 1168-9).

Green notices that *Cissites debeyi* lays its eggs in masses inside the galleries made by the Carpenter Bees with which the species is associated (*Ent. Mo. Mag.* [2], XIII, pp. 232-3).<sup>2</sup>

### Cerambycidae.

Saunders states that adults of *Batocera rubus* feed on the round buds, but not on the leaves, of the Pipal tree (*Trans. Ent. Soc.*, I, 1836, pp. 60-61). The development and habits of several Longicorns which bore in *Ficus elastica* are described by Dammerman (*Med. Afd. v. Plantenz.*, No. 7, Batavia, 1913, 43 pp., 3 pl.).

Larvae of *Stromatium barbatum* attack furniture in Calcutta. *Xystocera globosa* was present in large numbers in a tree which died recently on the Calcutta Maidan. All stages of *Logaeus subopacus* were found in a rotten log at Kavalai, ca. 2000 ft., in the Western Ghats in Cochin on Sept. 26, 1914. Similar larvae were abundant in rotten wood both there and at the base of the Ghats at about the same time of year, but later stages were only found in the one instance.

<sup>1</sup> Since named *T. himalayensis*, Stebbing. See *Indian Forest Insects*, London, 1914, p. 186.

<sup>2</sup> See also E. Bugnion "Le *Cissites testaceus*, Fabr. des Indes et de Ceylan, Métamorphoses—Appareil Génital", *Bull. Soc. Ent. Egypte*, 1909 (Cairo, 1910), pp. 182-200, pl. i-iii.

## Scolytidae.

The supposed effect of moonlight on the attack of the "shot-borer" is discussed in the *Journal of the Bombay Natural History Society* by Troup (XVII, p. 526), Barton-Wright (XVII, pp. 1026-7) and Stebbing (XVIII, pp. 18-26).<sup>1</sup>

Strohmeyer (*Ent. Blät.*, 1914, pp. 103-107) suggests that the group of bristles and processes on the head of the female of *Spathidicerus thomsoni* serves for the transport of ambrosia fungus spores. Mr. Beeson tells me that he has found inside the frontal processes of the swarming female of *Diaprus furtivus* bunches of small cell-like bodies of similar appearance to the clusters of ambrosia which occur in its galleries. They stain with cotton blue, but he has been unable to germinate them. The male of this species, he tells me, possesses a group of minute pores near the apex of each elytron, which secrete a white wax. The wax is moulded into a cylindrical tube which projects about a third of an inch from the entrance-hole in the bark of the host-tree. The male brings up the pellets of excrement from the sapwood galleries, in which the larvae live, into the wax-tube and, collecting a mass of material in a deep concavity at the posterior end of the abdomen, suddenly jerks the body outward and shoots the pellets for a distance of several feet from the trunk of the tree.

Mr. Beeson also tells me that the large concavities in the front of the head and the lateral processes on the antennal scape of the female of *Crossotarsus bonvouloiri*, and the processes on the mandibles of the female of *Diaprus quinquespinatus*, are used for picking up the eggs and carrying them about in the galleries.

## Curculionidae.

How a leaf-rolling weevil (*Apoderus* sp.) rolls up leaves and lays its eggs is recorded by Sage (*J.B.N.H.S.*, VI, pp. 263-4).

The habits and life-history of an aquatic weevil are described by Annandale and Paiva (*J.A.S.B.* [n.s.], II, pp. 197-200, figs. 1A-F).

*Alcides collaris* is noticed by Lefroy as a gall-producer (*J.B.N.H.S.*, XIX, p. 1007).

Notes on the habits and life-history of *Cyrtotrachelus longipes* are given by Witt (Indian Forester, XXXIX, pp. 265-272, pl. v).

Concerning the development and habits of *Aclees birmanus*, a borer in *Ficus elastica*, see Dammerman (*Med. Afd. v. Plantenz.*, No. 7, Batavia, 1913, pp. 29-30, 1 text-fig., pl. i, figs. 10a-b).

## STREPSIPTERA.

Green records the occurrence, in the Jassid *Thompsoniella arcuata*, of parasites belonging to this Order (*Spolia Zeylanica*, VII, p. 55).

<sup>1</sup> Mr. Beeson informs me that the species referred to in this discussion is *Platypus biformis*, Chap.

## LEPIDOPTERA.

## Rhopalocera.

Cases of butterfly migration are noted in the *Journal of the Bombay Natural History Society* by Aitken (XI, pp. 336-7 and XIII, pp. 540-1), Prall (XI, p. 533), Dudgeon (XIV, pp. 147-8), Nurse (XIV, p. 179), and Andrewes (XIX, p. 271); and in *Spolia Zeylanica* by Wickwar (III, pp. 216-8), Green (III, pp. 219-220), Fletcher (IV, pp. 178-9), Daniel (V, pp. 106-7) and Willey (V, pp. 186-8).<sup>1</sup>

Prall records the rate of flight of certain butterflies (*J.B.N.H.S.*, XI, pp. 533-4).

Henderson records the occurrence of *Melanitis ismene* at sea (*Spolia Zeylanica*, IX, pp. 45-6).

Ormiston contributes a note on the length of life of butterflies as winged insects (*Spolia Zeylanica*, IX, p. 143).

The enemies of butterflies are discussed in the *Journal of the Bombay Natural History Society* by Nurse (XV, pp. 349-350), Lefroy (XV, p. 531) and Aitken (XVI, pp. 156-7).

The capture of *Huphina remba* by a Lycosid spider is recorded by West (*Spolia Zeylanica*, V, p. 105).

Green refers to "the habits of the leaf-butterfly" (*J.B.N.H.S.*, XVI, p. 370), and Cave publishes "a note on *Kallima inachus*" (*Spolia Zeylanica*, V, p. 142).

The climatal changes of *Melanitis*, etc., are discussed by Manders (*J.B.N.H.S.*, XVII, pp. 709-720); and Aitken (*J.B.N.H.S.*, XVIII, pp. 195-197).

Some effects of moisture on the behaviour of butterflies are described by Cunningham ("Plagues and Pleasures", pp. 103-8).

Green describes the oviposition and early larva of *Jamides bochus* (*Spolia Zeylanica*, II, pp. 204-5), and the gregarious habits of the larva of *Parata alexis* (*Spolia Zeylanica*, III, p. 157).

An account of the habits of the leaf-cutting caterpillar of *Suastus gremius* is given by Willey (*Spolia Zeylanica*, VI, pp. 124-130, 7 text-figs.), who further notes (p. 125) the ability of the adult of this species to emit a loud clicking sound.

A note on the development and larval habits of *Aphnaeus hypargyrus* is contributed by Fraser (*J.B.N.H.S.*, XX, pp. 528-530, 1 pl.).

Mimicry in unpalatable caterpillars (*Papilio polytes*) is the subject of notes in *J.B.N.H.S.*, IV, by Hart (pp. 229-230) and Aitken (p. 317).

Carnivorous habits and cannibalism in caterpillars of butterflies are recorded in *J.B.N.H.S.*, XVIII, by Fischer (pp. 510-1), and Lefroy (pp. 696-7).

<sup>1</sup> See also Shelford, *J. Straits R.A.S.*, June 1903, pp. 203-4 (*Cirrochroa bajadeta*, Moore).

### Heterocera.

Lefroy records carnivorous habits and cannibalism in the larvae of moths (*J.B.N.H.S.*, XVIII, pp. 696-7). The coccidiphagous habits of *Eublemma* larvae, which are mentioned in this note, have also been recorded in *J.B.N.H.S.*, XIII, by Dudgeon, (pp. 379-380), and Green (p. 538).

The aerial dissemination of the larvae of a wingless moth is noted by Aitken (*J.B.N.H.S.*, V, p. 421).

Troup records a plague of the web-spinning caterpillars of *Naxa textilis* var. *hugeli* on the Silang tree, *Olea fragrans* (*J.B.N.H.S.*, XII, pp. 775-6).

Certain *Drosera*-eating larvae and their habits are described by Fletcher (*Spolia Zeylanica*, V, pp. 26-27, figs. 3-7 and pp. 95-97).

The larval habits of the Tineid moth *Melasma cnerga* form the subject of a note by Fryer (*Trans. Ent. Soc. London*, 1913, pp. 420-422, pl. xxi).

Green gives an account of the curious Scolopendriform caterpillar of *Homodes fulva* (*Spolia Zeylanica*, VII, pp. 166-7, figs. 8a-b), of a Geometrid caterpillar (*Comiboena biplagiata*=*Utiocnemis cassidara*) which disguises itself by attaching small pieces of leaves and withered flowers to paired fleshy processes of the body (*Spolia Zeylanica*, I, p. 74), and of the efficacy of the hair of a small Lithosiid caterpillar as a protection against ants (*Spolia Zeylanica*, VI, p. 135). Wise states that the hair which *Nepita conferta* works into its cocoon serves the same purpose, and calls attention to the male-attracting power possessed by females of this species (*J.B.N.H.S.*, II, pp. 54-5). Aitken, however, shows that the hair of the larvae of *Nepita conferta* does not protect them against toads (*J.B.N.H.S.*, XI, pp. 337-8).

The method by which certain Saturniidae cut their way out of their cocoons is described by Kettlewell (*J.B.N.H.S.*, XVII, pp. 541-2).

Meyrick (*Ent. Mo. Mag.* [2], XXV, p. 220) records Fletcher's discovery of a moth, to which he gives the name *Brachmia xerophaga*, symbiotic with *Stegodyphus* at Guindy near Madras. I have examined specimens of the spider with which it was found, and have identified them as *Stegodyphus sarasinorum*. More recently I have myself obtained the same species of moth from nests of the same species of spider near Balugaon in Orissa. All the moths I saw were on the outside of the nest, but the caterpillars were inside.

Fletcher mentions the occurrence of several specimens of *Ophideres fullonica* and *Cephonodes hylas* at sea (*Spolia Zeylanica*, III, p. 202). He also contributes a note on the significance of the stridulation of the Death's Head Moth (*Spolia Zeylanica*, IV, pp. 179-180).<sup>1</sup>

<sup>1</sup> See also Rutherford, *Spolia Zeylanica*, X, pp. 77-78. For collected observations on the stridulation of European Death's Head Moths see Tutt "British Lepidoptera," IV, pp. 406-8 and 447 (larva), 432 (pupa) and 444-453 (imago). According to a notice long exhibited in the insect gallery of the Indian Museum



Stridulating organs on the wings of certain Indian moths have been described by Hampson (*Proc. Zool. Soc. London*, 1892, pp. 188-193, 6 text-figs.).

With regard to the supposed stridulating organ found in males of the genus *Arcte* (pl. xxiii, fig. 7) Mr. Henry has sent me the following note on an observation he made a few years ago in the Matale District of Ceylon. "I was walking through jungle at dusk and noticed two dark moths with light patches on the underwings, which I am sure were *Arcte caerulea*, flitting up and down and round each other, and producing a curious clicking noise. Unfortunately at that time I was not specially interested in moths, so I neglected to preserve the specimens or to make a note of the occurrence. I was merely struck by the curious fact of moths producing a sound. It may have been a pair of males fighting (and I incline to this opinion) or a male courting a female."

Alarming colour and attitude, and also mimicry in certain caterpillars, are described by Annandale (*Proc. Zool. Soc. London*, 1900, pp. 855-857).

## DIPTERA.

### Psychodidae.

Concerning *Phlebotomus minutus* see Howlett, *Ind. J. Med. Res.*, I, pp. 34-8, 1 fig.

### Cecidomyiidae.

Stebbing describes the life-history and habits of a Cecidomyiid which produces false cones on *Pinus longifolia* (*Indian Forester*, XXXI, pp. 429-433, pl. xxxviii).

### Chironomidae.

The habits in all stages of the Colombo Lake Fly—since described by Kieffer (*Rec. Ind. Mus.* VI, pp. 136-137) under the name *Chironomus ceylanicus* (see Green, *Spolia Zeylanica*, VII, p. 50)—are referred to by Green, *Ind. Mus. Notes*, V (3), pp. 191-193, and Chalmers, *ibid.*, pp. 195-197.

The larva of a Chironomid, since described by Kieffer as *Chironomus fasciatiipennis*, is recorded by Annandale as feeding on—and in its very early stages sometimes feeding—*Hydra orientalis* (*J.A.S.B.* [n.s.], II, pp. 112-116; see also *Fauna of British India*, Freshwater Sponges, Hydroids and Polyzoa, pp. 155-6). Other Chironomid larvae (*Chironomus* and *Tanypus* spp.) are recorded by the same author as living in association with *Spongilla carteri* (*J.A.S.B.* [n.s.], II, pp. 190-4, figs. 2A-B). He also notices some Indian blood-sucking midges (*Rec. Ind. Mus.*, IX, pp. 246-7).

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the Indian species of Death's Head Moth stridulate by rubbing the tip of the proboscis on the ridged lower surface of the same appendage. I have had no opportunity of investigating this on a living specimen, but found no difficulty in artificially producing sound in this way on a freshly killed specimen that I once received.

### Culicidae.

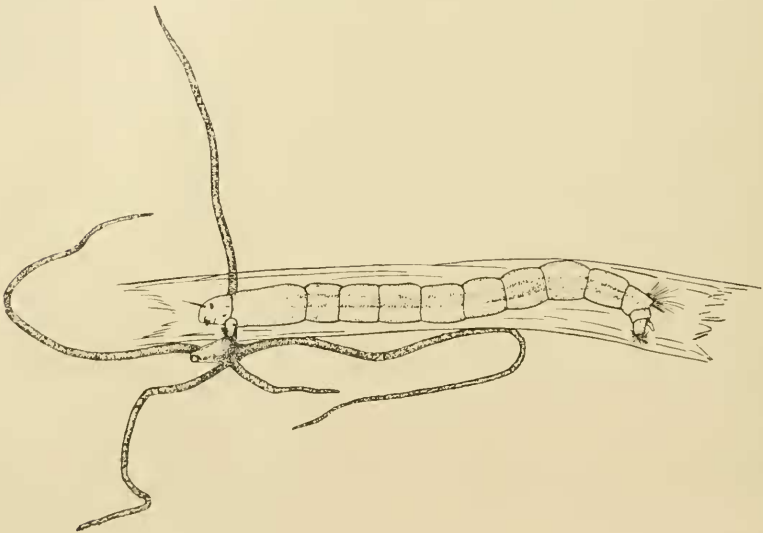
Ridley records the breeding of mosquitoes in pitchers of *Nepenthes* (*J. Straits R.A.S.*, No. 22, Dec. 1890, p. 430).

MacDougall notices the habits of *Corethrella*, (= *Ramcia*)<sup>1</sup> *inepta* (*Spolia Zeylanica*, VIII, p. 71).

The habits of *Toxorhynchites immiscricors* are described by Green (*Spolia Zeylanica*, II, pp. 159-164, 1 pl.; and *Rec. Ind. Mus.*, VII, pp. 309-310) and Paiva (*Rec. Ind. Mus.*, V, pp. 187-190).

Green has seen *Culex vishnui* sucking a syntomid moth (*Spolia Zeylanica*, IV, p. 180).

Paiva records the habits of *Aediomyia squammipenna* (*Rec. Ind. Mus.*, V, p. 202).



*Chironomus* larva attacking *Hydra*.

### Tipulidae.

*Conosia irrorata* usually sits with the front legs and middle femora stretched forwards, the distal parts of the middle legs bent outwards at a right angle, the hind legs stretched backwards, and the body and wings pointed obliquely upwards. All the legs lie flat on the supporting surface. In this position the fly looks more like a scrap of rubbish caught in a cobweb, than like a fly.

### Tabanidae.

Annandale gives an instance of adaptation in the habits of a Tabanid (*Rec. Ind. Mus.*, IX, pp. 245-6).

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<sup>1</sup> This synonymy is based on information sent by Mr. F. W. Edwards to Dr. Annandale.

### Asilidae.

Notes on the food of Asilidae are contributed by Bell (*J.B.N.H.S.*, XVII, p. 807) and Annandale (*Mem. A.S.B.*, I, p. 213). Notes on their oviposition are contributed by Kershaw (*J.B.N.H.S.*, XXI, pp. 610-3, pl. A-B) and Sen (*J.B.N.H.S.*, XXI, pp. 695-7, 1 fig.).

### Phoridae.

*Apiochaeta ferruginea*, a fly capable of reproducing and developing in the alimentary canal of living human beings, is the subject of two papers by Brunetti (*Rec. Ind. Mus.*, VII, pp. 83-86 and 515-6).

### Muscidae (s. lat.).

*Limosina equitans*, Collins (*Ent. Mo. Mag.*, 1910, pp. 275-279), was described from specimens found by Fletcher on a living Coprid beetle. See also Green (*Spolia Zeylanica*, IV, p. 183, and VII, p. 107).

Howlett describes the attraction of citronella oil for male specimens of two species of *Dacus* (*Trans. Ent. Soc. London*, 1912, pp. 412-418, pl. xxxix-xl).

A species of *Anthomyia*<sup>1</sup> is recorded by Cotes as parasitic on the eggs of locusts (*Proc. A.S.B.*, June 3, 1891, p. 94; and *J.B.N.H.S.* VI, p. 416).

Attacks of numbers of *Ochromyia jejuna* on a swarm of winged termites are noticed by Nangle (*J.B.N.H.S.*, XVI, p. 747),<sup>2</sup> Green (*Spolia Zeylanica*, III, p. 220 and IV, pp. 183-4) and Poulton (*T. Ent. Soc. London*, 1906, pp. 394-6). The observation that this fly has been seen taking away grains of sugar from large ants suggests that it may have been this insect which I several times saw taking the food of big ants in Cochin. On one occasion I saw a specimen flying about with a piece of food attached to its proboscis and a big ant attached to the other side of the piece of food.

Interesting observations on the feeding habits of certain blood-sucking Muscidae are recorded by Patton and Cragg (*Ind. Journ. Med. Res.*, I, pp. 11-25).

## HEMIPTERA.

### Pentatomidae.

The reaction of a Loris to *Aspongopus singhalanus* suggest that the taste of this bug, though at first startlingly pungent, is distinctly agreeable. The odour of the bug, though also pungent,

<sup>1</sup> *Anthomyia peshawarensis* (Bigot nom. nud.), Cotes, *Ind. Mus. Notes*, III, pp. 34-5—notes and figures but no description.

<sup>2</sup> Concerning the identity of the fly mentioned in this note see *Spolia Zeylanica*, IV, p. 184.

somewhat resembles essence of jargonelle (Green, *Spolia Zeylanica*, I, p. 73).

*Canthecona furcellata* eats Noctuid, Saturniid and Limacodid larvae (Antram, *J.B.N.H.S.*, XVII, pp. 1024-5).

Kershaw and Kirkaldy contribute biological notes on *Antestia anchorago* (*J.B.N.H.S.*, XIX, pp. 177-8, pl. B), on *Zicrona coerulea* (*t.c.*, pp. 333-6, 2 pl.), and on *Erthesina fullo* (*t.c.*, pp. 571-3, 2 pl., 1 text-fig.).

Concerning *Anasida orientalis*, *Plautia fimbriata*, *Nezara viridula* and *Aspongopus janus* see Mann (*J.B.N.H.S.*, XX, pp. 244-5 and 1166-7, 2 text-figs.).

Concerning *Coptosoma cribraria* see Ramakrishna Aiyar (*J.B.N.H.S.*, XXII, pp. 412-4, 1 pl.).

### Coreidae.

Concerning the development and habits of ? *Dalader acuticosta* see Annaudale (*Trans. Ent. Soc. London*, 1905, pp. 55-59, pl. viii).

*Serinetha augur* and *abdominalis* are said to be predaceous (*Indian Insect Life*, pp. 684-5). Green, however, points out (*Trop. Agric.*, Dec. 1909, pp. 482-3) that they suck fruit and seeds, and are preyed upon by a mimetic Pyrrhocorid *Antilochus nigripes*.

Mr. Beeson informs me that *Serinetha augur*, Fabr. is attracted to Kusum oil in October and December in Dehra Dun.

### Lygaeidae.

Concerning *Lygacus equestris* see Paiva (*Rec. Ind. Mus.*, I, p. 174).

Kershaw and Kirkaldy describe the development and habits of *Caenocoris marginatus* (*J.B.N.H.S.*, XVIII, p. 598, pl. figs. 1-7).

Galls formed on *Clerodendron phlomidis* by *Paracopium cingalense* are described by Fischer (*J.B.N.H.S.*, XX, pp. 1169-1170, 4 figs.).

### Pyrrhocoridae.

*Ipomoea* seed is recorded by Paiva as a food of *Lohita grandis* (*Rec. Ind. Mus.*, I, p. 175, 1 fig.).

Kershaw and Kirkaldy describe the development and feeding habits of *Dindymus sanguineus* (*J.B.N.H.S.*, XVIII, pp. 596-7, 4 text-figs., 5 pl. figs.).

### Henicocephalidae.

Green's observations on the habits of *Henicocephalus telescopicus* are recorded by Distant (*Fauna of British India*, Rhynchota, II, pp. 194-5).

*Henicocephalus basalis* lives under bricks with small red ants, on which I believe it to feed.<sup>1</sup> Females, usually winged but

<sup>1</sup> I have never managed to see this species feeding, but on one occasion a wounded ant was introduced unnoticed into a killing tube with one of them, and I have little doubt that it was introduced on the tip of the proboscis, from which it must have fallen off later.



occasionally apterous, do not appear to venture out at all by day, but males are sometimes to be found running about in the evening or early morning near bricks frequented by females.<sup>1</sup>

In Cochin I found a specimen of *Henicocephalus* sp. sucking a termite. The colony from which this termite was taken has been identified for me by Mr. Bainbrigge Fletcher as belonging to the genus *Anoplotermes*.

### Reduviidae.

Kinnear gives an instance of blood-sucking propensities in *Nabis capsiformis* (*J.B.N.H.S.*, XIX, pp. 534-5).

Concerning the occurrence of *Conorhinus rubrofasciatus* as a parasite of man see Green (*Spolia Zeylanica*, VII, p. 50).

*Harpactor flavus* ("chersonesus") when on the wing resembles a small bee, *Melipona vidua*, on which it has been seen to feed (*Fasciculi Malayenses*, Zool. II, p. 263).

Millipedes are recorded as the food of *Physorhynchus linnaei* (*Spolia Zeylanica*, III, p. 159 and VII, pp. 55-6) by Mr. E. E. Green, who tells me that, of all the Ceylon millipedes, pill-millipedes appear to be the only ones which are able to withstand the attacks of this bug. I have seen large millepedes killed and eaten by *Physorhynchus* in Ceylon and in Cochin.

*Physorhynchus linnaei* stridulates by rubbing the tip of its proboscis between its front legs (Green, *Spolia Zeylanica*, VIII, p. 299). I have observed this mode of stridulation in *Conorhinus rubrofasciatus*, *Ectomocoris cordiger*, *Pirates arcuatus*, *Pirates affinis* and *Isyndus pilosipes*.<sup>2</sup> The stridulating organs of *Conorhinus rubrofasciatus* and *Ectomocoris cordiger* are shown on pl. xxiii (figs. 23-24). That of the latter insect, in which the posternum is greatly prolonged between the anterior coxae, is more finely striated and produces a louder sound than that of the former.

A specimen of *Isyndus pilosipes* was found in June, 1914, near Darjeeling, sitting on a leaf with its proboscis inserted into the carcass of a small Elaterid beetle. As I approached with a view to capturing it with its prey, it quickly took fright; but instead of flying away it struck a menacing attitude, and, standing as high as possible on its middle and hind legs, it raised the front legs into a more or less horizontal position, extending them obliquely forwards and outwards; the antennae, which were similarly extended, were rapidly vibrated; and the proboscis, which had been withdrawn from the body of the Elaterid, was brought well into view by being bent downwards to its greatest possible extent.

<sup>1</sup> Most of my observations on this species were made in Mr. Green's garden at Peradeniya. After I left he noticed that males were much more abundant in the early morning than in the evening.

<sup>2</sup> See also A. Handlirsch "Zur Kenntniss der Stridulationsorgane bei den Rhynchoten. Ein Morphologisch-biologischer Beitrag" (*Ann. K. K. Naturhist. Hofmus. Wien*, XV, 1900, pp. 127-141, 15 text-figs., 1 pl.; and E. A. Butler "Stridulation in British Reduviidae" (*Ent. Mo. Mag.* (2) XXIII, 1912, p. 65).

I gathered the leaf, with the bug still standing in this attitude over its prey, and watched it for some minutes. Occasionally the front legs were lowered for a moment to grasp the edges of the leaf, the posterior end of the insect being on these occasions even further elevated than before, but they were never allowed to remain down long.

Finally I seized the bug by the thorax in order to transfer it to a killing bottle, when it at once set up a faint but distinct squeaking noise, something like that produced by longicorn beetles. The beats of this noise were found to correspond in time to the movements of the proboscis, whose tip was being rubbed vigorously up and down a well marked median longitudinal groove on the prosternum; and the noise was evidently produced by these movements.

Mr. C. A. Paiva tells me that a specimen of *Acanthaspis rama*, which he once found in a fissure of a large tree at Katihar in the Purnea District of Bihar, struck a menacing attitude when he tried to catch it. This species also possesses a stridulating organ between its front legs, and so do many other Indian Reduviids.

The habits of bugs belonging to the genus *Eugubinus* are very peculiar. The genotype (*E. araneus*, Distant<sup>1</sup>) is said to have been "found living in the nest of a spider (*Theridium* sp.)" at Uran near Bombay (Distant, *Fauna of British India*, Rhynchota, II, p. 207). I have found specimens at Ernakulam in Cochin (*E. intrudans*, Distant<sup>1</sup>), and in the Salt Lakes area near Calcutta (*E. reticolus*, Distant<sup>1</sup>). In both cases they were found in webs of *Cyrtophora ciccatorosa*, an Argiopid spider which spins a dome-shaped web. The web of this spider is really a horizontal orb-web pulled out of shape by a supporting framework of numerous irregular strands; it presents an appearance very unlike that of the orb-webs characteristic of other genera of Argiopidae, and superficially very like the irregular webs characteristic of the Theridiidae. Conspicuous web-spinning Theridiidae, though common round about Kandy and in the Cochin Ghats, seem to be comparatively rare in most parts of India, where *Cyrtophora ciccatorosa* is usually abundant; and it may be doubted whether one of the solitary webs of the Theridiidae would supply the bug with sufficient nourishment for development. I am inclined to think therefore, that the web from which the genotype was taken must also have belonged to *Cyrtophora ciccatorosa* and not to a Theridiid.

*Eugubinus*, like many other bugs of the sub-family Emesinae to which it belongs, is an excessively slender insect. It was originally described as being apterous and having two-jointed tarsi; but these are larval characters. So far as my observations go the adult is always winged and has three-jointed tarsi. It flies well, but does not appear to take flight very readily. When it settles

<sup>1</sup> *Entomologist*, Jan. 1915, pp. 8-9.

on a *Cyrtophora* web, instead of getting entangled it seems quite at home. When, however, it wishes to make its way into the inner parts of the framework, its long legs appear to be much in the way. If it cannot find room to get between the strands in the direction in which it wishes to go, it proceeds to cut some of them with its raptorial front legs; but these seem ill-adapted for the purpose, and progress is often very laborious and slow. Presumably, therefore, the unusual habits of the genus have been somewhat recently acquired.

*Cyrtophora ciccatorosa* is inclined to be gregarious, and although each spider makes for itself a separate dome, the frameworks of several webs are usually united. Males (which are minute) and young live in small domes in the common framework of the group and each female arranges her pear-shaped egg-cocoons in a string above the centre of her dome.

*Eugubinus* is often seen making its way towards the string of egg cocoons, and I suspect that their contents form its staple food. A specimen let loose in some webs in the Museum compound was seen more than once, soon after mid-day, with its proboscis inserted into one of the cocoons. This is not, however, the only food that it is able to take; for when I introduced some sweepings from among grass into a cage containing specimens that had had little or no food for several days, they began to investigate even grass seeds, and finally one of them made a meal off a moribund spider (? *Tetragnatha* sp.). Perhaps the ancestors of *Eugubinus* found insects caught in the outer parts of the framework of *Cyrtophora* webs an easy prey, and later found their way to the eggs in the interior.

The excessively slender body and legs of *Eugubinus*, and their variegated colour, make the bug somewhat difficult to distinguish among the strands of the webs of *Cyrtophora*, especially as only webs in shady situations seem to be frequented. But this alone seems insufficient to explain why the bug is allowed to destroy the spider's offspring. When specimens were let loose in webs in the Museum compound they shook the webs somewhat as they fell upon them. A spider immediately rushed out to one of the bugs, ran half way along its body, and seemed just about to strike when, instead of the bug writhing in its grasp as I expected, the spider fled back to its dome. I supposed that the bug must have emitted something highly distasteful to the spider; but next morning this very spider was seen making a meal off one of the bugs!

Green records the frequenting of the webs of *Archiopsocus* sp. by *Ploiariola polita*, and believes this Reduviid to be predatory on the Psocids in the webs (*Spolia Zeylanica*, VIII, p. 71).

#### Cimicidae.

The bat *Scotophilus kuhli* is recorded by Kunhikannan as a host of *Cimex rotundatus* (*J.B.N.H.S.*, XXI, p. 1342).

Cragg describes fertilization in *Cimex* (*Ind. J. Med. Res.*, II, pp. 698-705). The spermatozoa are introduced through an aperture on the fourth abdominal segment.

### Cicadidae.

In the preface to his "Monograph of Oriental Cicadidae" Distant refers to the natural enemies of the group, and to the voices of the males. Later (p. 1) he gives references "to most of the published information respecting the structural details of the wonderful sound-producing organs" (p. vi). Observations on the production of sound by Indian species have been recorded by Middlemiss (*Nature*, XXXIII, pp. 582-3).

Annandale describes the habits of *Dundubia intemerata* and *Huechys sanguinea* (*Proc. Zool. Soc. London*, 1900, pp. 859-862).

The liquid discharge made by Cicadas is noticed by Biscoe (*J.B.N.H.S.*, X, pp. 535-6).

A captive specimen of *Lemuriana apicalis*, which was recently watched in the Indian Museum, emitted from time to time a jet of colourless liquid with considerable force from its hinder end, while feeding on the sap of a piece of the tree on which it had been caught. The note of this cicada is not unlike that of a cricket, and may frequently be heard in trees round about (and even in) Calcutta during the rains; but this is almost the only specimen I have seen and the only one I have managed to catch.

*Huechys sanguinea* is sometimes plentiful on *Zizyphus* bushes near Calcutta in the spring. Dr. Annandale tells me that when in the Malay Peninsula he noticed that this cicada frequented bushes rather than big trees.

Dracott describes the emergence of cicadas from their nymphal skins, and the nymphs from the ground (*J.B.N.H.S.*, XXIII, pp. 379-380). His observations were made at Gangtok in Sikkim at an elevation of about 6000 ft. above sea level, on a plot of ground from which large numbers of specimens have been seen to emerge year after year.

### Fulgoridae.

Annandale shows that the peculiar prolongation of the head found in certain Fulgoridae is probably of use in jumping (*Proc. Zool. Soc. London*, 1900, pp. 866-868).

Concerning *Salurnis marginellus*, *Geisha distinctissima*, and *Neomelicharia furtiva* see Kershaw, *J.B.N.H.S.*, XXI, pp. 607-9, pl. A-B.

Concerning *Phromnia marginella* see Imms, *Mem. Manchester Lit. Phil. Soc.*, LVIII (4), 12 pp.; 2 pl.

### Membracidae.

Chatterjee describes the development and habits of *Oxyrhachys tarandus* (*Indian Forester*, XL, pp. 75-79, pl. iii-iv).



Several species of Membracidae are common on a number of different kinds of shrubs. They are usually sluggish insects and slip round the branch on which they are seated when disturbed. Only as a last resort do they jump or fly, although they can do both quite well. The posterior end of the female is armed with two pairs of fine lancets in a protecting sheath. With the aid of these the eggs are laid in rows embedded horizontally in the bark of the twig, from which only one end of each protrudes (pl. xxiii, figs. 16-17). The larvae (pl. xxiii, figs. 20-22) are brown or black, with an eversible reddish appendage at the posterior end of the body (fig. 22). They are commonly more or less gregarious. Even adults (pl. xxiii, figs. 17-19) seem to scatter little if at all when not compelled to do so. Consequently very large numbers are usually found living together on an infected bush. They are generally attended by big black ants (pl. xxiii, fig. 17).

### Cercopidae.

The habits of *Machaerota guttigera* have been described by Westwood from notes supplied to him by Mr. S. Green (*Trans. Ent. Soc. London*, 1886, pp. 329-333, pl. viii).

The habits of *M. planitia*<sup>1</sup>, which is common on *Zizyphus jujuba* in Calcutta (pl. xxiii, fig. 13), are very similar. The larva (pl. xxiii, figs. 9-12) always lives head-downwards in its tube, which, though closed at the base, is not entirely shut off from the twig to which it is attached. I have never seen the larva come out to feed, as Westwood supposed that of *M. guttigera* must do; and it is so helpless when removed from its tube that I doubt if it could safely do this. It must, I think, obtain all its nourishment from the supporting twig through the pore at the base of the tube, through which its stylets may sometimes be seen to protrude when the tube is separated from the twig.

As Green watched the commencement of tube-building by some newly-hatched larvae of *M. guttigera*, he felt that "it must be a close fit by the time they are ready to assume the perfect state." The difficulty is overcome by each larva producing two tubes—first a small one, and then a larger one. A separate small tube is always found at the base of each big one (pl. xxiii, fig. 8), I have seen the larva of another tubicolous form, protected only by a frothy fluid, at work commencing the latter at the base of the former.

The habits of another insect, *Hindoloides indicans*, Distant<sup>2</sup>, which is common here on *Zizyphus jujuba*, are similar to those of *Machaerota*. I have, however, several times watched the emergence of its adult at about sunset. In *Machaerota guttigera*, according to Green, emergence occurs shortly after sunrise, and I think this is probably also the case with *M. planitia*.

<sup>1</sup> I am indebted to Mr. Distant for this identification.

<sup>2</sup> *Ann. Mag. Nat. Hist.* (8) xv, pp. 506-507.

The tubes of the *Hindoloides indicans* (pl. xxiii, fig. 14) are easy to distinguish from those of *Machaerota planitiae* by their more wrinkled appearance, and by their form, the free portion being shorter and less straight. This may perhaps account for the curious fact that although adult of *Machaerota* are often much more abundant than those of *Hindoloides*, the reverse is the case with their tubes; for most of these tubes are always found to be old and empty, and presumably the long straight distal portion of the tube of *Machaerota* soon gets broken off.

The larvae of the two genera are much alike; in their later stages they can, however, be distinguished by the size of the developing process of the scutellum (compare figs. 12 and 15, pl. xxiii).

*Machaerota planitiae* is recorded in "Indian Insect Life" (p. 733) from *Zizyphus jujuba* (ber), from *Aegle marmelos* (bael) and from cotton, as well as from "other plants in India." Early in February of this year I found its tubes common at Pusa on ber and on cotton. On the former it was accompanied by tubes of some species of another genus of which I failed to obtain adults. Only *Machaerota* appeared to occur on cotton. I doubt whether any of the tubes found on bael belonged to this genus. As the mixture of genera on *Zizyphus* has been so long unnoticed, it is not unlikely that the genera and species to be found on different plants will prove to be greater than has hitherto been supposed.

### Jassidae.

Annandale notes that the phenomenon of "weeping trees" is sometimes due not to Cercopidae, but to Jassidae (*Rec. Ind. Mus.*, III, pp. 293-4). Other families of Homoptera appear also to take part in its production.

Lefroy (*J.B.N.H.S.*, XX, pp. 235-6) notes that the Mango Jassid *Idiocerus* appears only to breed when mango trees shoot freely. In the district where his observations were made this occurred in March only for five years in succession. During the sixth year, however, an exceptionally wet season caused the trees to shoot again in September. "Whether from this reason or not, the *Idiocerus* also bred and one distinct brood was produced at a season when we have never before observed it breed at all." A similar restriction of the breeding season may perhaps account for the freedom of Calcutta during the greater part of the year from the notorious "green-fly" (*Nephotettix bipunctatus* and *apicalis*) which appears every year towards the end of the rains in such myriads that it is often almost impossible to approach a glowing arc-lamp near the open maidan.

Concerning the eggs of *Tettigoniella spectra* see Lefroy, *J.B.N.H.S.*, XX, p. 236.

### Aleurodidae.

Peal describes the function of the vasiform orifice of the Aleurodidae (*J.A.S.B.*, LXXII [II], pp. 6-7).

### Coccidae.

Imms records the occurrence of *Dactylopius citri* in ants' nests (*Rec. Ind. Mus.*, VI, p. 111).

### MYRIAPODA.

The habits of a number of Malay Myriapods are described by Flower (*J. Straits R. Asiatic Soc.* No. 36, 1901, pp. 1-25).

Concerning the food of Scolopendridae see Wells-Cole, Okeden and Cumming (*J.B.N.H.S.*, XII, p. 214; and XV, pp. 135, 1 pl., and 364-5 respectively).

Mr. G. Mackrell tells me that *Ethmostigmus pygomegas* is common on his tea garden in Sylhet just below the surface of the ground. Specimens are sometimes found in earth round the roots of grass growing at the bottom of a bush; but they more often crawl into light soil leaving no visible hole, or in between clods of earth. In captivity they appear to be nocturnal, and to shun light. Their food consists chiefly of worms and small insects, and they seem to be fond of Acridiids and Gryllids.

I have already described the stridulation, apparently to attract attention away from the creature that had cast it, of a detached leg of *Scutigera decipiens* (*J.A.S.B.* [n.s.], IX, pp. 415-6). More recently I noticed a detached leg of a Cochin species moving in the same manner, and on holding it to my ear was able to hear it squeaking. In this case, however, the squeak was much fainter, and was produced by legs which remained *in situ* as well as by others.

The occurrence of purplish-red millipedes in herds is noticed by Cunningham ("Plagues and Pleasures", p. 193). I have sometimes seen such herds on the muddy banks of the Havildars' Tanks on the Calcutta maidan, especially, if I remember rightly, in the spring.

Some of the larger species of Indian millipede exude an evil smelling coloured fluid when disturbed. The common big black species in the Cochin Ghats does this, but nevertheless falls an easy prey to its enemy the Reduviid bug *Physorhynchus*. A still larger black species, in which the middle of each segment is girdled with extra thick chitin, and the caudal horn is exceptionally long, emits a particularly virulent fluid which not only smells, but also stains and burns one's hands. This species was only found near the head of a small valley at Kavalai (Cochin Ghats) where, however, it was much commoner than the common form of the district. I regret that I did not also try *Physorhynchus* with it.

*Arthrosphaera aurocincta*<sup>1</sup>, Pocock, a pill-millipede common in the Cochin Ghats—the commonest round Parambikulam at the end of the State Forest Tramway—surprised me by the vibrations which it usually set up when caught. On holding it to the ear a squeaking noise was heard. The noise would, however, have passed unnoticed but for the vibrations which called attention to it. I would have put this forward in support of Arrow's theory (*Fauna of British India*, Lamellicornia, I, p. 14) that the object of stridulation is often not noise, but vibrations that will bring discomfort to an enemy on contact, but that the pill-millipede seems to require no greater protection than its excessively hard carapace. Pillmillipedes, as already pointed out (p. 511), appear to be the only millipedes capable of withstanding the attacks of *Physo-rhynchus*. The fact, however, that stridulation always took place when the animal was seized and rolled itself into a ball points to its association with the instinct of defence. I have only noticed stridulation in the one species, although I specially looked out for it in other species found in Cochin. I never heard or felt it in an open specimen; consequently I found it impossible to locate the organ which produced the sound.

#### ARACHNIDA.

#### XIPHOSURA.

Notes on the habitat and breeding habits of *Limulus moluccanus* and *L. rotundicauda* are contributed by Annandale (*Rec. Ind. Mus.*, III, pp. 294-5). Sewell (*Rec. Ind. Mus.*, VII, pp. 87-8) records the capture of the former species in a surface townet in water of about 10 fms. depth. See also Flower, *J. Straits R. Asiatic Soc.*, No. 36, July 1901, p. 26.

#### SCORPIONIDEA.

Parturition in a scorpion is the subject of a note by Dreckman (*J.B.N.H.S.*, III, pp. 137-8, fig. facing p. 69). The species dealt with is incorrectly named, and evidently belongs to the genus *Heterometrus*, perhaps to the species *H. phipsoni*.

Pocock describes the habits in captivity of *Parabuthus capensis* and *Euscorpius carpathicus* (*J.B.N.H.S.*, VIII, pp. 287-294). Neither of these are, however, Indian species.

Newnham (*Nature*, LVI, p. 79; reprinted in *J.B.N.H.S.*, XI, pp. 313-4) records the carrying off of a large flower by *Parabuthus liosoma* one evening at Aden. The scorpion was holding the flower over its back in one of its claws. When camping at the foot of the Ghats in the Ratnagiri District I once saw a scorpion in the same way carry off a piece of white paper that had fallen from the table at which I was working in the open after dark.

<sup>1</sup> I am indebted to Dr. F. Silvestri for this determination.



The stinging power of scorpions forms the subject of notes by Green, Coomaraswamy and Drieberg (*Spolia Zeylanica*, III, pp. 197 and 215-6, and IV, p. 33).

Concerning the habits of *Archisometrus mucronatus* and other Malaysian species see Flower, *J. Straits R. Asiatic Soc.*, No. 36, July 1901, pp. 30-36.

## PEDIPALPI.

### Thelyphonidae.

The earliest mention of the habits of Indian Thelyphonidae appears to be by Stoliczka (*J.A.S.B.*, XLII [II], p. 127), who records his own observations and those of Mr. Peal. Peal's observation that "the *Thelyphoni* are generally found underneath the bark of decayed wood in groups, rarely singly" is somewhat surprising. All the specimens presented by him to the Indian Museum are, however, *Uroproctus assamensis*, a species whose habits have rarely come under my observation.

The next reference is by Wood-Mason (*Proc. A.S.B.*, 1882, pp. 59-60).<sup>1</sup> Observations of a similar nature to those made by Stoliczka and Wood-Mason are recorded by Oates (*J.A.S.B.*, LVIII (II), pp. 4-5).

Flower refers to the habits of the Siamese *Thelyphonus schimkewitschi* (*J. Straits R. Asiatic Soc.*, No. 36, July 1901, pp. 37-9).

A brief note by Green on the habits of *Thelyphonus sepiaris* will be found in *Spolia Zeylanica*, IV, p. 181, and one by myself on those of *Labochirus proboscideus* in *Spolia Zeylanica*, VII, pp. 44-46, fig. B.

A further contribution to the subject is made by Fischer, who describes the courtship dance of *Thelyphonus sepiaris* (*J.B.N.H.S.*, XX, pp. 888-9).

The habits of *Uroproctus assamensis* as observed by Kemp during the Abor Expedition are referred to in my note on the Pedipalpi collected on that Expedition (*Rec. Ind. Mus.*, VIII, p. 127).

I am now able to describe in greater detail the habits of several Indian species of Thelyphonidae. My earliest and most extensive observations were made on *Labochirus proboscideus*, and these will be described first.

*Labochirus proboscideus* is not uncommon under logs of wood and large stones in the jungles of the Kandy district of Ceylon; but it is only to be found when the ground has been thoroughly

<sup>1</sup> Stoliczka does not refer to the fluid of his Thelyphonids as *inodorous*, as stated by Wood-Mason, but as not having any *offensive* odour. In some species it is violently pungent and resembles acetic acid. In others it is more like essence of jargonelle and, although not very pleasant, is by no means pungent—individual opinions would probably differ as to whether it was offensive or not. In Wood-Mason's specimens the odour was "exactly like that of a highly concentrated essence of pears, but . . . when deeply inhaled had all the characteristic smell and pungency of strong acetic acid." Compare pp. 509-510, above.

wetted by the rains, or occasionally near water in the dry weather. Thus before the rains I only obtained two or three specimens, and these were all found under stones on moist (but not swampy) ground within a few yards of the Mahawelli Gunga.

Specimens are always found on the ground, never on the under side of their shelter. When first uncovered they usually remain quite still for a time before attempting to hide. Sometimes a burrow is found under the shelter. In this case the *Labochirus* usually sits facing it, and disappears down it as soon as any attempt at capture is made. In other cases any burrow there is must be throughout its length in contact with the shelter.

In dry weather, when *Labochirus proboscideus* is difficult to obtain, it presumably burrows till it reaches soil that it finds comfortably moist and then remains there. If unable to find moisture it dies in a few days; and I found it impossible to keep this species in captivity for any length of time unless the floor of its cage was kept covered with moist soil, when no difficulty was experienced.

Both sexes construct burrows in which to live, digging the soil away with their second pair of appendages. As the excavation deepens they enter it head first, collect some soil between the second appendages, and then back out and deposit it at a little distance from the entrance. The tibial apophyses seem to enable them to carry more soil than would otherwise be possible. Of two very young (probably one year old) specimens kept in captivity one made a U-shaped burrow with one entrance under cover and the other exposed; but I have not been able to recognize any other instance of this being done.

*Labochirus* appears to be incapable of inflicting any injury on man. When irritated it usually extends its pedipalps to their fullest extent, and would no doubt use them in defence against a sufficiently small opponent; but it is a nervous creature and prefers retreat. It will not attack even a defenceless cockroach if it is very large, but will gladly kill and eat small ones.

The stink-glands are no doubt of service in self-defence. On two occasions I have seen the fluid ejected as a small cloud, but this is rare; one of the specimens noticed was a female, the other was almost certainly a male but escaped capture. According to Wood-Mason (*Proc. A.S.B.*, 1882, p. 60) the stink-glands are larger in female Thelyphonids than in males. The apertures of these glands are easily seen on each side of the medially situated caudal appendage (dorsal) and anus (ventral). If some object is placed near these apertures when the creature is irritated the drop of fluid ejected will be found upon it. It has "all the characteristic smell and pungency of strong acetic acid", but in this species I have never noticed any odour "like that of a highly concentrated essence of pears" (Wood-Mason, *l.c.*).

It is almost impossible to observe the feeding habits of these nocturnal animals in their natural haunts; and even in captivity they are very shy of any light that may be brought to bear upon

them when they have emerged from their hiding-places in search of food. What their usual food is, and how often they get it under natural conditions I am unable to say. In captivity they appear to feed as often as suitable food is given, suitable food being winged termites, small locustids, blattids, etc., especially when these are disabled. But of larger insects and of very active ones they are easily frightened. A disabled locustid will be snatched at eagerly if held in front of a specimen ; when however, it is presented alive and kicking *Labochirus* will extend the second pair of appendages as if to seize it, but in reality as a menace, and will then back away.

Food is seized between the second appendages and held between them and the head. In the male of this species little or no use is made of the chelae, though at times the long movable finger may be embedded in the prey and bent over so as almost to meet the tibial apophysis. The very long gnathobases of the second appendages appear to be of some use in supporting the food above the ground and keeping it in the neighbourhood of the mouth. In the female the second appendages are much shorter and stouter than in the male, and the form of the tibial apophysis renders it scarcely possible that the movable finger of the chela should be brought into apposition to it ; the gnathobase is also very much shorter. How far these structural differences affect the mode of feeding I am unable to say, as the only female kept in captivity, was, I believe, damaged when caught, and died after a few days without having taken any food.

Concerning the part played by the chelicerae in feeding I am also unable to say anything, as they were always obscured by the anterior end of the carapace and by the food itself ; presumably they are used much as in *Phrynichus* (see below). Another function of the chelicerae was, however, repeatedly seen, namely the use of the brushes with which they are provided for cleaning the terminal joints of the legs. Hansen (*Arkiv för Zool.*, II [8], p. 8) says " The function of such hairs, ' blood hairs ', is no doubt to intercept the blood of the prey when this has been cut to pieces." Doubtless they function to some extent in this way, but their use for cleansing purposes is manifested every time a specimen gets its feet a little soiled.

In *Labochirus*, and probably in all the Thelyphonidae, the antenniform legs are ordinarily held directed forwards and usually somewhat outwards in an arched posture. As the animal moves along they are lowered from time to time till the tip comes in contact with the ground, and then raised again, but the two are lowered alternately, not simultaneously.

I found it very difficult to determine whether these creatures drink water, as so many Arachnids do. I believe, however, that they do so, and on one occasion I saw a specimen apply its mouth to water placed in its cage on a leaf, although it refused to take any notice of this until a lamp that was near had been removed. I could not see whether any sucking movements were set up or not.

With regard to the breeding habits of this species my information is of the scantiest, but I believe, from the evidence of dissections, that the time for egg-laying was rapidly approaching when I left Ceylon in August. The young appear to attain a length of about 1 cm. (exclusive of the tail) during the summer after they are hatched, and to take two years more to come to maturity; but the evidence for this is not so extensive as in the case of *Charinides* and *Phrynichus* (see below, pp. 531-532).

It was not until August<sup>1</sup> of last year that I saw the courtship "dance" of a whip-scorpion. The specimens concerned were a pair of *Thelyphonus sepiaris* which I caught in Orissa and brought back with several others alive to Calcutta. Their positions, when I first noticed what was going on, were those described by Fischer (*J.B.N.H.S.*, XX, pp. 888-9). They are shown in pl. xxiv, fig. 25. The left antenniform leg of the female was crossed above the right, and about three joints of the tarsus of each of these legs were left exposed by the chelicerae of the male. The pair walked slowly round the cage in which they were confined, the male going backwards and the female following him. Once or twice they passed an unattached male, when the mated male left go his hold of the antenniform leg of the female on the side next the possible rival and seemed to prepare for defence. But none was needed.

Soon this type of "dance" ceased, the female raised her abdomen in the air, and the male commenced stroking her genital segment with his antenniform legs. These legs usually passed between the third and fourth legs of the female but sometimes behind the fourth; their tips were usually crossed, the right being above the left as a rule. The chelae of the male were held open and were kept slightly moving over the dorsal surface of the abdomen (pl. xxiv, fig. 26).

I expected this to lead up to the culminating action. But the female was a small one, and her genital segment was not fully developed. Probably she was immature. For this reason, perhaps, the first type of "dance" was soon resumed and continued till I went to bed. It was in progress at about 7 A.M. next day, but ceased soon afterwards. Next night it was repeated. After that the female died.

*Thelyphonus sepiaris* is much better able to withstand draught than is *Labochirus proboscideus*. It lives in much drier situations, and will live in a dry cage without water for several weeks at least, without apparent discomfort. It seems, too, to be of a somewhat less timid disposition. Green (*Spolia Zeylanica*, IV, p. 181) says that it emits an odour resembling strong acetic acid. The defensive odours of the Thelyphonids I have met with vary in character from this to something closely resembling essence of

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<sup>1</sup> Mr. Fischer informs me that his observations (see above, p. 519) were made after dusk in June. Rain had fallen and brought out the Thelyphonids, which climbed about his tent. The dance took place on his writing table in the tent.



jargonelle, and I regret that I have not made notes of the scents of the various species.

Mr. H. N. Ridley has sent me several specimens of *Thelyphonus linganus*. He compares their defensive odour to that of chlorine gas, and says he knows of no other animal able to emit so widely diffused and powerful an odour for its size. This species eats crickets, woodlice, etc., and Mr. Ridley once found a specimen eating a cricket in the day-time, though usually the species is nocturnal. The modification of one or more of the sixth to eighth tarsal joints of the antenniform legs of the female of this and allied species of *Thelyphonus* is perhaps due to the development of special organs for use during courtship; for it is at about this point that these appendages are held in the chelicerae of the male during that process in the only species of *Thelyphonus* in which it has been described.

The odour emitted by *Uroproctus assamensis* resembles essence of jargonelle. This species lives in a damp region, and does not seem able to withstand drought in the way that *Thelyphonus sepiaris* can.

Mr. G. Mackrell tells me that *Hypoctonus oatesi* exudes a fluid smelling like acetic or formic acid, though perhaps a little more pungent. It inhabits country where stones are not to be found, living in the banks of roads and cuttings and in the vacated burrows of ants. In June specimens usually have to be dug out from a depth of about 18 inches, but in August they are often found at the entrance of their holes. On one occasion two females were found in a nest swarming with ants. Both had young clinging to their abdomens.

I have found several species of *Hypoctonus* under stones in Burma. I have not been able to study their habits in captivity, but there seems every reason to believe that they are very like those of *Labochirus proboscideus* and *Thelyphonus sepiaris*.

I do not think any of the Thelyphonids I have studied can be luminous as suggested by Sorensen (*Ent. Med.* 1894, pp. 175-177); and I can hardly believe that the sting described by Flower (*Journ. Straits R. Asiatic Soc.*, July 1907, pp. 38-39) was really due to the *Thelyphonus schimkewitchi* that he was handling when he received it. I have handled other species frequently without receiving any harm.

### Schizomidae (Tartarides).

The only species which I have myself found in any abundance are *Schizomus* (s. str.) *crassicaudatus*, *S. (Trithyreus) peradeniyensis*, and *S. (T.) vittatus*, all from Ceylon, and it is only to these that the following account refers.<sup>1</sup> The Calcutta form—*S. (T.) lunatus*—I have found under bricks on somewhat moist stiff clay; and so

<sup>1</sup> A preliminary note on the habits of these species appeared in *Spolia Zeylanica*, VII, p. 46, fig. C. Nothing else beyond a brief note on a species from caves near Moulmein (*J.A.S.B.* [n.s.], IX, p. 417) appears to have been written about the habits of Indian species.

far as I know its habits are much the same as those of the Ceylon species.

*Schizomus crassicaudatus* was only found under bricks, etc., on or close to open ground (usually grassy lawns) more or less shaded by trees, while the other two Ceylonese species named were found only among dead leaves, especially where these formed a layer of considerable depth and were matted together by fungal hyphae, in the midst of the shrubberies in the Peradeniya Botanical Gardens. *Schizomus crassicaudatus* was never found in company with the other two.

The ground was more or less moist, especially in the shrubberies, during almost the whole time I was at Peradeniya; but shortly before the break of the rains I found specimens (probably *Schizomus crassicaudatus*) on a very dry slope a few yards away from a little stream. A specimen of *S. peradeniyensis* subsequently lived in a corked tube in Calcutta without food or water for about three months. When a drop of water was placed near it by means of a fine pipette the soil was so dry that it was some time before the water began to be absorbed, but the *Schizomus*, after examining it carefully with the mobile tips of its antenniform legs, took no further notice, and made no attempt to drink.

I have only once seen a Tartarid take food. On this occasion a minute white centipede (*Scutigera*) was seized by the second pair of appendages in much the same way as a fly is seized by the chelicerae of a spider. When secured it was carried off into a burrow to be eaten.

On one occasion I put two specimens (both female) of *S. peradeniyensis* in a tube partly filled with soil, and two of *S. vittatus* in another. Before very long the individuals of both pairs were found to be facing each other, their antenniform legs extended obliquely forwards, those of the one crossing those of the other. This futile hostility continued for several hours, after which the specimens were separated. Apparently neither dared either to attack the other from in front, or to leave her rear unguarded for a moment. When, however, a larger number of specimens are similarly confined, but on the slippery glass bottom of a tube without any soil, they frequently become panic-stricken and then attack each other in the same way as they attack their natural prey. But even a large number of specimens may safely be collected together in a tube when loose soil is provided for them to run about on.

When touched from in front *Schizomus* usually tries to escape by giving a sudden jump backwards. The stink-glands are no doubt used for defence; and when a number of specimens are caught and put together in a tube they may be observed to emit a distinct odour of acetic acid.

The chelicerae and second pair of appendages, besides being used for offensive and defensive purposes, are used for cleaning the feet; and the form of the second appendages allows them to

be used simultaneously with the chelicerae for rubbing the feet, and not only for holding them in position.

A specimen of each of the three Ceylon species was kept alive by itself in a separate tube about one-third full of carefully packed soil. Each made two or three burrows before very long; but they rarely entered any of them even by day, and when disturbed they never seemed to know where to find them though the whole diameter of the tubes was little more than two centimetres. It is therefore rather difficult to believe that these burrows are used as permanent homes, and this is borne out by the following facts concerning the habits of *Schizomus crassicaudatus* in the open.

Whenever a specimen of this species was discovered by the removal of the brick under which it had been hiding, it would dart spasmodically about looking for somewhere to hide again, with no more idea than one of the captive specimens just mentioned as to where to find a suitable hole; and the hole into which it finally disappeared seemed to me to be as a rule a wormtrack or something of that kind. Further, it is apparently possible to go on collecting specimens from under one brick two or three times a week for an indefinite period, each time removing every specimen found; which seems to prove conclusively that they can have no fixed abode, but wander about from place to place among the roots of the grass not far from which they are always found.

In the case of the shrubby forms which occurred in extensive layers of dead leaves it was impossible for such observations to be made; but if these species habitually lived in burrows it is difficult to understand why they were most abundant among the leaves and not in the soil below them; and why a specimen in captivity entirely without cover very rarely entered any of the two or three burrows that it made.

Of what use, except for reproductive purposes, the burrows can be it is difficult to see; but of the three specimens which made burrows in captivity only one—*Schizomus crassicaudatus*—produced eggs. This one constructed a little cavity against the side of the glass tube in which it was confined, at a depth of about 15 mm. below the surface of the soil (pl. xxiv, fig. 27). As far as I could see this nest had no opening, and the *Schizomus* never left it to my knowledge till the eggs disappeared. It was lined with soil cemented together in some way; when this lining was shaken free from the glass (to which it was similarly cemented) the damage was quickly repaired; but unfortunately I never saw this being done. The eggs were seven in number, subspherical (flattened at the poles), of a glistening white colour, and were neither tightly pressed together nor enclosed in a brood-pouch of any kind. They were arranged so that one of them was above and one below the centre of a ring composed of the five others; the general shape of the mass as a whole was approximately spherical, and it appeared to be attached to the abdomen only in the region of the genital aperture. The abdomen was carried at an angle to the rest of the body as shown in the figure. As a rule the creature

rested on one of the sides of the nest with the thorax vertical and the abdomen horizontal, but it was impossible to see it sufficiently clearly in that position for it to be drawn. The nest and eggs were first noticed on Sept. 12, about three weeks after the creature's arrival in Calcutta, but they may have been produced a few days earlier; no changes were seen to take place in them, and eventually they disappeared and the mother left her nest. The mother had been captured and placed by herself in a tube at Peradeniya on August 14.

### Tarantulidae.

The habits of the cavernicolous Charontinae, *Stygophrynus cavernicola*, *S. cerberus*, and *Catagius pusillus*, have been described by Annandale and myself (*J.A.S.B.* [n.s.], IX, pp. 417-420).

A small species of Charontinae, *Charinides bengalensis*, is common in Calcutta. I have been able to study its habits in greater detail than those of the cavernicolous species. They closely resemble those of the Ceylonese species of *Phrynichus* on which a preliminary note has already appeared (*Spolia Zeylanica*, VII, pp. 43-4, fig. A) and also those of *Phrynichus nigrimanus*<sup>1</sup>, a species not uncommon in the Eastern Ghats. The habits of all of these may now be considered together, the few differences between them being noticed as occasion arises. There is no reason to suppose that the habits of cavernicolous species differ in any essential points from those of these species, apart from the fact that *Stygophrynus* does not habitually live under stones or logs of wood, but on the walls of caves.

All species that I have observed<sup>2</sup>, except those of the genus *Stygophrynus*, live in crevices among bricks or stones, or under logs of wood, where there is room for them to move about freely. They are almost always found on the under side of the object beneath which they hide. *Charinides*, and doubtless other Charontinae also, having pulvilli on its feet, can walk up a vertical piece of polished glass, or even across its lower surface; but *Phrynichus*, which has no pulvilli, cannot do this. It is unlikely that any Tarantulids can burrow; and a specimen of *Phrynichus ceylonicus* that was brought to me after being dug out of a hole it had been seen to enter, can hardly have made the burrow for itself.

*Phrynichus ceylonicus*, s. str., appears to be a regular inhabitant of bungalows; but its variety *pusillus* and *Charinides bengalensis* seem to visit them rarely, and it is very doubtful, on account of the inability of these species to live in the absence of moisture,

<sup>1</sup> This and other species of *Phrynichus* have been provisionally grouped by Kraepelin under the one name *P. reniformis*, Linn. See *Rec. Ind. Mus.*, XI, pp. 447-448.

<sup>2</sup> Mr. Ridley informs me that *Sarax singapuræ* is found under bricks and among dead leaves; he thinks the latter form its usual home. When specimens are collected from under the bricks, others quickly take their places.



whether they ever make them a permanent abode.<sup>1</sup> That *P. ceylonicus*, *s. str.*, does this there can, I think, be no doubt. The first specimen I saw alive was found in Mr. Green's workshop after dark; it was sitting on the wall close to a large bookcase behind which it retreated as soon as I attempted to catch it. It must have been several days at least since it first came there, for a cast skin, which from its size appeared to have belonged to it, was found close by upon the wall, with cobwebs attached to it; and the animal itself had already become thoroughly hard and dry. On the following night the specimen (I have no doubt it was the same) was found again in the same place and captured; it lived healthily in a bare breeding cage for over two months, when I preserved it prior to leaving Ceylon. These striking creatures are also well known to residents in the island who frequently mention some particular room as one in which a specimen is often seen.

The difference between *Phrynichus ceylonicus* and its variety *pusillus* in their ability to stand dryness is very marked.<sup>2</sup> The former will live healthily for at least a fortnight, and usually longer, in a bare cage with a wooden base and frame, glass sides and a perforated zinc top, whereas the latter always dies in a few days if not supplied with constantly moist soil. *P. ceylonicus*, variety *pusillus*, appears to be confined to the moist jungles of the lower hills of Ceylon. *P. ceylonicus*, *s. str.*, on the other hand, seems to be most abundant in places where climate or a porous soil produce drier conditions. On the only occasion on which I was able to test the capacity of *P. ceylonicus*, variety *gracillibrachiatus*, one specimen of this form and one of variety *pusillus* were put into a bare cage in which two specimens of *P. ceylonicus*, *s. str.*, were living, after giving them ample opportunity of satisfying their thirst. Variety *pusillus* was found dead next evening and variety *gracillibrachiatus* on the following evening.

It may be noted here that *P. ceylonicus*, variety *pusillus*, besides requiring damper surroundings than *P. ceylonicus*, *s. str.*, appears to be a much more thirsty animal; and I am inclined to think that small specimens of the latter are of a more thirsty disposition than old ones, though the evidence for this needs amplification.

*Charinides bengalensis* also requires a certain amount of moisture in its surroundings, and no doubt it is on this account that it always chooses for its abode some pile of bricks in a sheltered place where the ground is moistened nightly in the dry cold weather of Calcutta by a heavy dew.

Tarantulids, like other Pedipalpi, are nocturnal feeders; by day they hide themselves away. When one is exposed by turning over its shelter, it crouches flat down, and when eventually it darts suddenly away it rarely tries to escape to other stones, how-

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<sup>1</sup> I have no evidence on this point with regard to *P. nigrimanus* and other species.

<sup>2</sup> *P. nigrimanus* probably resembles *P. ceylonicus* in this respect, but the evidence is somewhat conflicting.

ever good the cover they may offer. I have several times chased a specimen of *P. ceylonicus*, variety *pusillus*, round and round a stone in this way for some minutes before being able to catch it, when the stone was resting on a mass of others among which the creature could have got away with the greatest ease, had it thought of doing so. *P. ceylonicus*, *s. str.*, and *Charinides bengalensis* appear to be equally prejudiced in this respect.

When caught, even the large *P. ceylonicus* is apparently quite incapable of inflicting any injury. All species of *Phrynichus* are, however, able to give a distinct (but painless) nip between the terminal finger of the second appendages and the distal spines of the tibia, and when caught are apt to claw viciously at one's hands as often as they get the chance.

No stink-glands are known in Tarantulids, and I have never noticed any particular smell associated with them.

What Tarantulids live upon when left to find their own food I cannot say; but in captivity cockroaches, crickets, and sometimes a green locustid will be taken by *Phrynichus*. *P. ceylonicus*, *s. str.*, naturally manages larger specimens than *P. ceylonicus*, variety *pusillus*, can do. I believe that *Charinus bengalensis* will take very small cockroaches (? and woodlice) and have seen it eat swarming termites that have shed their wings. Tarantulids are extremely nervous beasts and winged termites are far too active for them. A specimen of *P. ceylonicus*, *s. str.*, became pitifully panic-stricken when one or two of these were placed in its cage, raising itself upon its legs with a start every time a termite touched it.

The following account, based on a particular instance, will serve to show how Tarantulids obtain their food.

A recently captured *Phrynichus* was sitting under a tile where it had been hiding all day, when it became aware of a wingless cockroach (*Dorylaca rhombifolia*) engaged in feeding upon a lump of bread in one corner of the cage. The *Phrynichus* left its retreat and cautiously approached to within a short distance of the cockroach when, after extending both arms, it made a sudden grab; but only the bread was secured, and this was not appreciated. For a few moments the *Phrynichus* waited in a defiant attitude, slightly raised upon its long legs, with its arms partially extended: then it subsided flat on the ground again. In the meantime the scared cockroach had retreated into another corner of the cage, where it was soon followed by the *Phrynichus* which made another grab at it. This time it was caught and brought within reach of the chelicerae, with the assistance of which it was finally demolished. Another cockroach was killed and partly eaten later on during the same night, after which the *Phrynichus* fasted for six days, when it ate another cockroach. This fast of several days after each meal appears to be the normal habit of all the species of *Phrynichus* I have studied; and the remarkable eagerness which newly caught specimens always show for food leads me to believe that in the wild state they are rarely able to secure as much food as they would like. This suggestion is further supported by the

difficulty which they always seem to experience in the capture of active prey.

It is very difficult to observe the method of capture on account of the rapidity of this action; but repeated observations have convinced me that although both arms are shot forwards in any attempt to seize the prey, the actual capture is usually between the terminal claw and the spines near the end of the second appendage of one side only. As will be seen on reference to fig. 28 (pl. xxiv) these spines are so arranged as to form a very effective hand, the terminal claw being apposable to the proximal of the two long dorsal spines at the distal end of the tibia, and the spine on the penultimate joint to the distal of these. As the claw and all three spines are rigid and sharply pointed it would be not unnatural to suppose that when grasping the prey they enter its body in such a way as to render its escape quite impossible. As a matter of fact, however, the strength necessary for this is apparently absent, and I have seen even a soft-bodied cricket unsuccessfully attacked time after time as its movements brought it within reach of a *Phrynichus*; and although once or twice it appeared to have been secured by one hand the other was never used to assist in holding it, with the result that it escaped before it could be brought within reach of the chelicerae.

Once within reach of these appendages, however, all chance of escape disappears. The prey, which remains alive for a time, is held between the two hands, often with the terminal finger embedded in its tissues, whilst parts of it are scooped into the region of the mouth by the terminal joint of the chelicerae, the sharp saw-like armature of their under surface perhaps being of use in severing pieces of a suitable size from the main mass. When such a piece had been secured by the chelicerae it is thoroughly masticated by vertical, combined with slight longitudinal, movements of these appendages, which rub it against each other and against the gnathobases of the second appendages. As the terminal joint is apparently kept closed except when required to scoop in a fresh piece of the edible material it is difficult to see any use to which the double row of teeth on the basal joint can be put. The long anteriorly projecting sternal spine no doubt assists in keeping the food from falling to the ground when it passes into the immediate neighbourhood of the mouth.

I have only once seen *Charinides* feed. Unlike *Phrynichus* it captured its prey between the two second appendages, not in one hand, the terminal claw and the spines of the hand and finger being unable to close against the spines at the end of the tibia (pl. xxiv, fig. 29). The terminal claw pressed into the body of the prey, probably penetrating the tissues, and other spines appeared to help to some extent. The capture was extremely sudden, and the details were only seen by repeatedly removing the captured prey until the *Charinides* became nervous, and acted more slowly.

It has already been mentioned that *Phrynichus ceylonicus*, variety *pusillus*, is a much more thirsty animal than *P. ceylonicus*, s. str. When thirsty, however, specimens of both species behave much alike if water is sprinkled into their cage. As long as small drops only are met with these are caught up between the spines of the hand, whose arrangement, when the hand is closed, is admirably adapted for this purpose. The drop is conveyed by the hand to the chelicerae which suck it off with movements like those of mastication. When, however, a small pool is found on a leaf or other receptacle the chelicerae are inserted directly into this and with the same movements proceed to suck it up. Once when I attempted to give water to a specimen of *P. ceylonicus*, variety *pusillus*, which did not want it, a drop that had been placed on the chelicerae was drawn off into one of its hands, and flung aside by a sudden movement of the arm. I have not seen *Charinides* drinking.

The brushing up of the other appendages by the chelicerae may often be seen in all species. I am inclined to think that this is sometimes done chiefly for the sake of the moisture upon them, small though this must be; at least the evident relish with which it is sometimes done after water has been sprinkled about, and before the creature has found any separate drops, emphatically suggests this. When the feet have to be brushed they are supported in position by the hands. The great care which is taken to keep the tips of all the appendages free from dirt is very striking. In the case of the second appendages this is probably due to the presence on the two terminal segments of an elaborate system of spines, clubbed hairs and pits, which may perhaps constitute an organ of taste or smell, functioning as a test of the suitability for food of anything that is captured. In the case of the feet it is probably necessary for the pulvillus in *Charinides*, and the pulvillus-like pad in *Phrynichus*, as well as the claws, to be kept perfectly clean if they are to be used effectively; and it is not unlikely that tactile organs may be concentrated in this region.

That the antenniform legs should be kept clean, not only at the tip (as are the other appendages), but also throughout a considerable part of their length, is clearly necessary on account of their great service to the animal as feelers. When *Phrynichus* moves sideways (as it usually does) these legs are extended outwards, their mobile extremities feeling cautiously about in all directions; when it moves forwards they are extended forwards somewhat as in the Thelyphonidae; and I have seen them, too, when the animal was at rest, extended straight outwards and then slowly rotated, the one forwards and the other backwards, so as to sweep as large an area as possible round the body. When undisturbed their position is rarely very different from that shown in *Spolia Zeylanica*, VII, p. 43, fig. A.

To what extent the sense of vision has been replaced in these creatures by senses localized in the anteniform legs I am unable to state with certainty. When a specimen is first found and



exposed to light by turning over the stone on which it is resting, instead of at once trying to escape it crouches close down upon the stone as already noted, and remains motionless for a time, no doubt trusting to its inconspicuousness when in this position for safety. When eventually it darts round to the under side of the stone this may be due to its preference for an inverted position and not necessarily to its dislike of light. A touch from a foreign body upon the antenniform legs or other part of the animal instantly puts it to flight. That *Phrynichus* is sensitive to light, however, becomes inconveniently evident as soon as one attempts to study its habits; and I am inclined to believe that its sight is of use in seeking for prey, though I have not been able to apply any conclusive test of this.

All Indian and Ceylonese species probably breed at about the same time of year.<sup>1</sup> I first found egg-laden females of *P. ceylonicus*, variety *pusillus*, on July 20th at Peradeniya, but the eggs were all well advanced in development. This was also the case with similar specimens of variety *gracillibrachiatus* found at Nalanda a week later. The embryos are carried under the abdomen, where they are supported by a membrane secreted for the purpose. All egg-laden specimens kept in captivity died before the young were hatched, but it is probable that the maternal habits closely resemble those of *Charinides*, which are described below. The number of eggs carried by a female *Phrynichus* appears to be about fifteen for *P. ceylonicus* variety *pusillus*, about 40 for variety *gracillibrachiatus* and about 60 for *P. ceylonicus*, *s. str.*

*Charinides bengalensis* breeds in July and August, and sometimes earlier. A specimen in captivity produced eggs on June 26. An egg-laden female, caught on Aug. 29 and kept in captivity, hatched its young on Sept. 23. These were six in number. Before the evening of the day on which they appeared all of them had freed their appendages and climbed on to the dorsal surface and sides of the abdomen of the mother; they were entirely white, though their bodies became faintly darker next day, and their second appendages lacked the characteristic spines of the adult. Two or three eggs which failed to hatch remained for a time attached to the abdomen of the mother as before. On the night of Sept. 27-8 all six of the young ones cast their skins; they then assumed a distinctly greenish colour, and the characteristic spiny armature of the second appendages appeared. The young and their cast skins remained upon the mother during that day, but by the next morning the former had wandered away by themselves, and the latter had disappeared.

Immediately after the first moult the carapace is a little over 1 mm. in width. From a series of over twenty specimens

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<sup>1</sup> *P. nigrimanus* appears to breed somewhat later than some others. I failed to find any ovigerous females at Barkul in Orissa when I went to look for them at the beginning of August, and saw no young ones likely to have been newly hatched.

collected one evening in September, it appears that during the first year its width increases to about 2 mm., during the second year to about 2.5 mm., and during the third to about 3 mm. At this period the arms of the male assume their distinctive length, and maturity is probably reached. Whether large specimens reach their maximum size at the same time, or whether this maximum (about 3.5 mm. thorax-breadth) is only reached subsequently, I am unable to say.

In *Phrynichus ceylonicus*, variety *pusillus*, and probably in other Phrynichinae also, the period of growth appears to be about the same; but the difference between the one-year-old specimens (thorax-width about 4 mm.), which are of a chequered green and yellow colour with conspicuously banded legs, and the much larger two-year-olds (thorax-width 7-8 mm. as a rule), of darker and more uniform colour, is very much more marked than between these and the adults, which as a rule are very little larger than them.

### SOLIFUGAE.

C. E. C. Fischer contributes some notes on the habits of *Galeodes indicus* to the *Journal of the Bombay Natural History Society* (XX, pp. 886-7).

### ARANEAE.<sup>1</sup>

#### Miscellaneous.

An instance of an apparently unprovoked assault by a spider on man is given by Cunningham ("Plagues and Pleasures", p. 209). The spider was dislodged with difficulty, but no after effects of the bite are recorded.

A spider's web suspended from a beam, and apparently kept taut only by the weight of a stone over four feet from the ground, is recorded by Sawrey-Cookson (*J. Sarawak Mus.*, I, p. 123).

### Aviculariidae.<sup>2</sup>

Wood-Mason's account of the discovery of stridulating organs in a member of this family—*Chilobrachys* ("Mygale") *stridulans*—is recorded in the *Proceedings of the Asiatic Society of Bengal* for 1875 (p. 197). It has been reprinted in the *Annals and Magazine of Natural History* ([4] XVII, p. 96). A more detailed account is to be found in the *Transactions of the Entomological Society of London* (1877, pp. 281-2, pl. vii). In view of the fact that the stridulating organs of *C. fumosus* appear to be of a more primitive type than those of *C. stridulans* (*J.A.S.B.* [n.s.] X, pp. 416-417, pl. xxi, figs. 5-6) I noticed with interest when at Kalimpong that,

<sup>1</sup> See also Workman, "Malaysian Spiders" (Belfast, 1896).

<sup>2</sup> Theraphosidae, Pocock, *Fauna of British India*, Arachnida. I have followed Simon's classification and nomenclature (*Histoire Naturelle des Araignées*, I and II, Paris 1892 and 1897) on account of its completeness.

although the former species behaves like the latter when angry, it can only produce a faint rattling sound. The latter is said by Wood-Mason to hiss loudly.

Notes on the habits of large "bird-eating" spiders, doubtless of this family, are contributed by Macpherson and by Morris (*J.B.N.H.S.* I, pp. 28-29, and IV, pp. 69-70). In both cases the species is identified as "*Mygale*" *fasciata*, a name now confined to a Ceylonese species of *Poecilotheria*. The subjects of the former note lived in burrows, so probably belonged to the genus *Chilobrachys*. The genus of the subjects of the latter note may possibly have been *Poecilotheria*, but the species was an Indian one.

Pocock (*J.B.N.H.S.* XIII, pp. 121-2) discusses notes on the habits of "bird-eating" spiders, and records observations showing that the genus *Poecilotheria* is arboreal. Annandale (*Mem. A.S.B.* I, p. 216) states that *P. striata* is apparently not uncommon on *Acacia arabica* near Pamben. Flower refers to the habits of the Malaysian *Coremiocnemis cunicularius* (*J. Straits R. Asiatic Soc.* No. 36, July 1901, p. 42).

Walsh notices the habits of a trapdoor spider from Orissa, which he describes as *Adelonychia nigrostriata* (*J.A.S.B.* LIX [II], pp. 269-270). Specimens which he sent to O. P. Cambridge were described by the latter at about the same time under the name *Diplothele walshi*, by which the species is now generally known.

The nests of *Sason cinctipes* were pointed out to me at Peradeniya by Mr. Green. They are constructed on flat moss-covered rocks and walls, and are roofed in by two rounded flaps of equal size, hinged together to form a single 8-shaped structure, and attached to the lower part of the nest at either end of the hinge. These flaps are covered with fragments of moss, etc. and are flush with the moss growing round about them. Consequently they are very hard to see. The spider sits beneath them, and can get out by raising either of them.

All species with which I am acquainted belonging to the subfamily Ischnocoleae live under stones and logs of wood. They do not appear to make burrows.

*Cyriopagus* (" *Melopoeus* ") *minax*<sup>1</sup> lives in silk-lined burrows which are not closed by a door of any kind.

### Uloboridae.

Most of the Indian Uloboridae known to me live in groups, often in association with a web spinning spider of some other family. In Cochin I found a nest of the common gregarious spider, *Stegodyphus sarasinorum*, with the orb-webs of a small Uloborid spread around it. When disturbed the Uloborids retreated in among the *Stegodyphi*. I gathered the branch and destroyed most of the Uloborid webs in so doing ; but the spiders

<sup>1</sup> Concerning the generic name of this spider see *Rec. Ind. Mus.* XI, p. 281.

came out during the night and made fresh ones, in the centres of which they remained so long as they were not disturbed.

Uloborid webs were several times seen grouped round the web of *Psecchus alticeps* in Cochin. One species seems to be definitely associated with *Cyrtophora ciccatorosa* in the Indian Museum compound, though I never saw it here till towards the end of last year. A somewhat larger species lives in groups of orb-webs in the Museum compound, but does not appear to be specially associated with any other spider. This species, and perhaps one other of similar habits, occurs also at Pusa, where Uloborids are found in association with *Nilus* sp., *Gasteracantha brevispina*, and *Cyrtophora ciccatorosa*. Another species found at Pusa spins solitary orb-webs over slight depressions on the sunny side of the trunks of smooth-barked trees.

One Uloborid found singly in Cochin spins two horizontal orb-webs, one above the other. The upper web is flat and finely spun, with a meshed hub on the under side of which the spider rests. The lower web is funnel-shaped with open hub, and is of coarser build.

#### Psechridae.

*Psecchus* ? *singaporensis* has been found in the Batu Caves, Selangor, out of reach of daylight (Flower, *J. Straits R. Asiatic Soc.* No. 36, July, 1901, p. 45).

*Psecchus alticeps* spins a large irregular web not unlike that of a Theridiid. One end of this web is always in contact with a tree-trunk, stone or bank of earth, to which the spider escapes with extraordinary rapidity when disturbed. The species is very common in the Cochin timber forests, but very difficult to catch.

A species of *Psecchus*, common at Pashok and Kalimpong in the Darjeeling District (ca. 4000 ft.), constructs a large and coarsely spun tunnel, the upper part of which spreads out to form a somewhat extensive roof-like snare—something like a *Pardosa* web (see below) inverted, but coarser in every way. The structure of the snare resembles that of the snare of *Stegodyphus* described below. I have not been able to examine a fresh snare in detail, but a microscopic examination of an old one showed that the silk was also very like that of *Stegodyphus* both in structure and in variety.

#### Eresidae.

The genus *Stegodyphus* is represented in India by several species; but only one, *S. sarasinorum*, seems to be abundant. The abundant and widely distributed form whose habits are described by Jambunathan (*Smithsonian Misc. Coll.* XLVII, pp. 365-372, pl. I.<sup>1</sup>) must presumably therefore have belonged to this species, on the habits of which Fischer has since contributed a few notes (*J.B.N.H.S.* XVIII, pp. 206-7).

<sup>1</sup> Banks has added a useful bibliography of the literature on social spiders to this paper.



Fischer's observations on the way in which these social spiders treat their victims is not in accordance either with Jambunathan's observations or my own. Instead of the prey being left to die as stated by Fischer, I have always found that anything caught in the web, whether by day or by night, is at once attacked. Under suitable conditions, however, very extensive snares may be spun, and it is possible that insects caught in the part of a large snare furthest from the nest may not attract attention so readily as do those caught near the nest.

The nest in which the spiders hide by day is a tough mass of cobweb mixed with dead leaves, insect integuments, etc. (pl. xxv, fig. 30). At dusk the spiders come out and float threads of silk from the upturned abdomen in the usual way, till one or more of them gets attached to some object at a little distance from the nest. These threads are then strengthened, and form the foundations of irregularly meshed snares (pl. xxv, figs. 30-31). The foundations of these snares are composed of one or more strands of relatively coarse silk. Between, and often along, these strands, strands of another kind are laid (pl. xxv, figs. 31-33). These are broader and have a softer and more woolly appearance; when carefully examined they are found to consist of a fine central thread overlaid with irregularly twisted threads and a sticky foam-like silk that I suppose to be the product of the cribellum. The hind legs may always be seen working against this organ when these strands are produced. The second type of strand is not only very sticky but also very elastic. Strands of this type unite the foundation lines in all directions, and when an insect gets caught among them they give before its struggles, and are not liable to break. Snares seem, however, to suffer from the weather; and many strands may be broken as the captured prey is dragged along towards the nest to be eaten.

Repairs and extensions are always carried out after sunset; but the spiders seem to be ready for food at any time. A fly thrown into the snare always brings them out at once. How the presence of prey in the snare is detected I have not been able to determine with certainty. If the snare is disturbed by one's finger the spiders hastily retreat into the nest. This suggests that sight is of use in this connection; but a dead fly was found to attract no attention. A specimen of the Rutelid beetle *Adoretus*, on the other hand, was at once pounced upon when placed in the snare although its movements were quite unlike those of the fly. Perhaps, therefore, touch calls the attention of the spiders to the presence of something in the snare, and sight determines their action towards it. The slaying of a large and strongly chitinized insect like *Adoretus* is a much more difficult feat for the spiders than is the slaying of a fly; but they persist until it is accomplished.

Associations of other animals with African species of *Stegodyphus* have been recorded by Marshall (*Zoologist*, [4] II, pp. 417-422) and Pocock (*Ent. Mo. Mag.*, [2] XIV [XXXIX], pp. 167-170).

Marshall describes a dormouse which lives in *Stegodyphus* webs and ultimately drives out the spiders; and both authors refer to a Microlepidopteron which lives with the spiders in their nests. Such a moth has recently been found associated with *Stegodyphus sarasinorum* in India (see above, p. 506). A Uloborid spider makes use of the webs of *Stegodyphus* (see above, pp. 533-534). Other associations, probably of a more casual nature, may also occur; and when pulling *Stegodyphus* nests to pieces in Orissa in order to obtain lepidopterous larvae I found in addition the following animals alive within them: one cribellate spider (? Dictynidae), one centipede (? Geophilidae), one large Lepismatid and two minute beetles (Anthicidae and Clavicornia).

### Pholcidae.

Concerning *Artema atlanta* see Flower, *J. Straits R. Asiatic Soc.* No. 36, July 1901, p. 43.

At least two species of Pholcidae are common in Calcutta, one much larger than the other. The former is usually found hanging by its long legs from its untidy web. The latter, which probably belongs to the genus *Pholcus*, is often seen in a similar position, but seems to be more of a wanderer, and I have twice seen it using its extraordinarily delicate legs as a snare for insects. On the first occasion the captive was an earwig (*Nala lividipes*). The earwig seemed much the stronger of the two antagonists, but was encircled by the spider's legs, which were too slender to be seized, and the spider's body was raised out of reach of danger by them. From time to time the spider lowered its body and struck at the earwig; but it was always restrained from effecting its purpose by a flourish of the earwig's abdomen. When the earwig tried to escape the spider went with it, taking care not to let it go from between its legs. Finally, however, the earwig's patience proved greater than the spider's, and it got away. On the second occasion the captive was a small Tipulid, and I have little doubt that the spider would soon have been victorious, but that the contest took place on a wall, from which both combatants ultimately lost their hold.<sup>1</sup>

### Argiopidae.

An instance of a small bird being caught in the web of a large Argiopid—doubtless *Nephila maculata*—is recorded by Sherwill (*J.A.S.B.* XIX, pp. 474-5). The "young spiders (about eight in number and entirely of a brick-red colour) feeding upon the carcass" were probably either males or parasitic Theridiids.

<sup>1</sup> More recently I have seen a hard-shelled jumping Chrysomelid beetle of considerable size (about 5 mm. long) similarly attacked by this spider. In this instance the spider had succeeded in attaching its silk to the victim and was busy spinning over it by the time it was seen. The spider stood high above its victim as usual, and appeared to be arranging the threads with its hind legs.

Further notes on the habits of *Nephila maculata* (?) and other species) are given by Cunningham ("Plagues and Pleasures", pp. 203-5 and 210) and Fischer (*J.B.N.H.S.* XX, pp. 526-528 and 887-8, pairing habits). Brief notes on the habits of this species and of a few other Argiopids found in the Malay Peninsula are recorded by Flower (*J. Straits R. Asiatic Soc.*, No. 36, July 1901, pp. 43-4).

*Argiope catenulata* seems to be confined, near Calcutta,<sup>1</sup> to the Salt Lakes area, where it spins an orb-web surrounded by numerous irregular lines between bushes of the low holly-like mangrove, *Acanthus ilicifolius*. *Argiope pulchella*, which is common among larger bushes in the Salt Lakes area, as well as elsewhere, spins a simple orb-web.

*Orsinome marmorea* spins large and more or less horizontal webs between rocks above rapidly running streams at an altitude of about 1,500 ft. in the Cochin Ghats. Several webs are usually grouped together; often they are stretched above waterfalls. When the spiders are disturbed they fall into the water, which washes them away. When they reach a rock they cling to it, and remain an inch or two below the surface till danger is over. Males and females were sometimes found together in the middle of a web with their heads in contact. Presumably they were pairing, but I had not time to investigate this fully.

*Herennia ornatissima* spins its orb-web close to a tree-trunk. Dr. Sutherland tells me that at Kalimpong he has found the female in the middle of her web, and sometimes the male in the web with her. In Cochin I always found the female<sup>2</sup> in a small silk-lined concavity on the tree-trunk near the web; and when a male was present it was in a similar nest close beside that of the female. The specimens were brownish in colour and they were very difficult to distinguish from irregularities of the bark.

The Indian species of *Cyrtophora*, like those of other countries, spin more or less dome-shaped webs; and most of them are more or less gregarious. The web of *C. citricola* is spun horizontally in the midst of an irregular mass of supporting lines, and has the characteristically fine mesh and delicate texture of the domes constructed by its allies; but it is scarcely raised in the centre. Mr. W. H. Phelps informs me that the web is always made at night. First radial lines are constructed as if for an ordinary orb-web. Then the spiral is commenced, and fresh radii are run out from time to time between the others, this filling in of the radial spaces being done piece by piece, not by a succession of complete whorls. When the web is about half finished the centre is raised as far as it is intended to be by the attachment of lines from above, after which it is completed.

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<sup>1</sup> It is also recorded from places such as Peradeniya, where conditions are quite unlike those of the Calcutta Salt Lakes and there is no *Acanthus ilicifolius*.

<sup>2</sup> I did not however, find many specimens.

On one occasion Mr. Phelps saw a specimen of *C. ciccatorosa* construct its cocoon. A soft loose sheet about an inch and a half long and a quarter of an inch wide was prepared first, on this the eggs were laid, after which it was rolled up and suspended above the web. The eggs hatch about three weeks after they are laid, and the spiders develop very rapidly.

The occurrence of a predaceous bug in the webs of *C. ciccatorosa* has already been noticed (above, pp. 512-513). The eggs of *C. feae* are parasitized by a Hymenopteron, both sexes of which are winged.<sup>1</sup>

### Thomisidae.

Trench describes how "a lemon-coloured spider with a triangular body and long yellow legs" sitting "on one of those virulent mauve zinnias" where "there was no effect whatever of any protective colouration" captured a bee-hawk moth (*J.B.N.H.S.* XX, p. 876). The spider was presumably a Thomisid.

Mrs. Drake has sent me from Serampore a number of specimens of *Amyciaea* sp., a mimic of the red ant *Oecophylla smaragdina*, together with a specimen of a bug, *Armachanus monocerops*, which mimics both, resembling the spider even more closely than it does the ant. Of the habits of a female *Amyciaea*, which she kept in captivity, she writes: "It is interesting to watch her method of securing a red ant. When one is put under her glass it at once goes towards the spider, who backs away from it or lets herself down by a cable if there is no room to draw back, after which she follows up and springs on it from behind. Then comes the curious part. She does not retain her hold but leaps down and waits. Next, cautiously advancing to its head, she walks round it as if to make quite sure it is dead, and finally, after lightly touching it, she begins her meal, every now and then moving on with her prey held up just as the ants carry their finds. Her extreme carefulness looks as if she had instinctive knowledge of the power of the ant's jaws, for I suppose had she herself been bitten she would not have survived. I had a male killed by a red ant the other day. I have only seen this kind of spider near red-ant settlements, and of the ten seen at different times nine were eating red ants, and the tenth was letting itself down by a cable just over a red ants' road. I believe these drop lines help to entangle a stray foraging ant, and while it strives to free itself the waiting spider springs upon it."

### Clubionidae.

The habits of the common Calcutta house-spiders of this family are described by Cunningham ("Plagues and Pleasures", pp. 206-

<sup>1</sup> Bugnion and Popoff have described from Ceylon *Baesus apterus*, a parasite with wingless females obtained from the eggs of a spider determined as *Argiope aetherea*, Walck. from which those of *A. catenulata*, Dol., were infected in captivity (*Rev. Suisse Zool.* XVIII, 1910, pp. 729-736, pl. v). The former spider has perhaps been incorrectly identified, for *A. aetherea* is a Papuan species which does not appear to be known from the Oriental Region (see Thorell, *Ann. Civ. Mus. Genova*, XVII, 1881, pp. 68-71).



208). These spiders are *Spariolenus tigris* and *Heteropoda venatoria*. They are probably about equally common, but the former is more often seen than the latter, as it seems to be less sensitive to light and the female often makes her home on the whitewashed wall of a staircase or bathroom, where she may be found day after day for weeks together. The male of *Spariolenus tigris* seems to be much rarer than the female, although the two sexes of *Heteropoda venatoria* are about equally common. Both species kill and eat cockroaches and crickets, which in some instances at least are not killed immediately they are bitten. Concerning *Heteropoda venatoria* see also Flower, *J. Straits R. Asiatic Soc.*, No. 36, July 1901, pp. 46, where *H. thoracica* is recorded as cavernicolous.

### Lycosidae.

A species of *Pardosa*, common in hedge-bottoms in the plains of Cochin, spins a silken tube open at both ends, the upper end leading out on to a silken platform. Mature females may often be seen at the entrances of their tubes, each with a male (sometimes two) keeping guard on the platform outside. When disturbed the female disappears into the tube followed by the male. Egg-laden females are not attended by males.

### Attidae.

Notes on ant-mimicing spiders are given by Rothney (*Trans. Ent. Soc. London*, 1889, p. 354; reprinted, *J.B.N.H.S.*, V, pp. 44-45) and Walsh (*J.A.S.B.* LX [II], pp. 1-4).

The mimicry of Mutillids by spiders is recorded by Green (*Spolia Zeylanica*, IV, pp. 181-2—spider *Caenoptychus pulchellus*, see *Spolia Zeylanica*, V, pp. 190-1; and *Spolia Zeylanica*, VIII, pp. 92-3, 1 pl.) and by myself (*Rec. Ind. Mus.* VII, p. 87). I take this opportunity of pointing out that my observations were made in Orissa, not in Calcutta as stated by Green.

### Acari.

The habits of *Trombidium grandissimum* are described by Annandale (*Mem. A.S.B.* I, pp. 216-7).

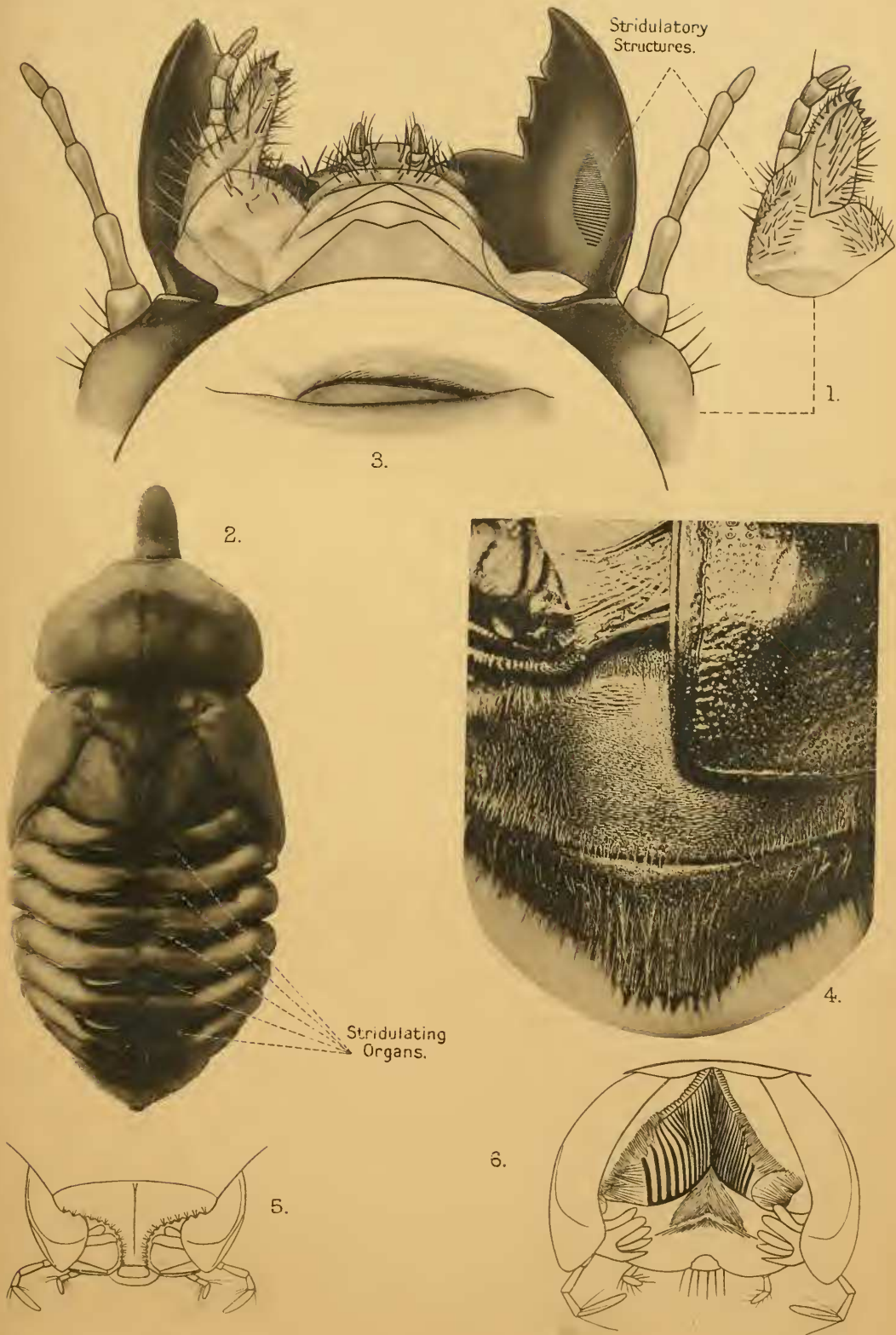
## EXPLANATION OF PLATE XXII.

### *Oryctes rhinoceros.*

- FIG. 1.—Mouthparts of larva from below, with left maxilla removed and turned over to show supposed stridulatory structures.
- „ 2.—Pupa from above showing stridulating organs.
- „ 3.—Left anterior stridulating organ of pupa more highly magnified.
- „ 4.—Posterior end of abdomen of adult, with left elytron removed, showing the ridges with the aid of which the insect appears to stridulate.

### *Adoretus* spp.

- „ 5.—Mouthparts of *A. versutus*—the labrum slightly raised, the mandibles widely and maxillae more moderately opened.
- „ 6.—Mouthparts of *A. lasiopygus*—the labrum removed, the mandibles and maxillae very widely opened to show the molar teeth of the former. This figure is more highly magnified than the last.



D. N. Bagchi, del.

S. C. Mondul, photo

LAMELLICORN BEETLES.

## EXPLANATION OF PLATE XXIII.

### *Arcte caerulea.*

- FIG. 7.—Posterior part of abdomen of male from above, after removal of the scales, to show the stridulating plate.

### *Machaerota planitia.*

- „ 8.—Tubes on a twig of *Zizyphus jujuba*.  
„ 9.—Larva.  
„ 10.—A more advanced larval stage.  
„ 11.—Last larval stage from above.  
„ 12.—Last larval stage from the side.  
„ 13.—Adult.

### *Hindoloides indicans.*

- „ 14.—Tube with larval exuvium and newly emerged adult.  
„ 15.—Last larval stage from the side.

### *Otinotus oneratus.*

- „ 16.—Eggs in bark of *Zizyphus jujuba*, seen as a transparency.  
„ 17.—Adult females with eggs, on stem of *Bauhinia varians*, accompanied by black ants (*Camponotus compressus*).  
„ 18.—Adult from the side.  
„ 19.—Adult from above.  
„ 20.—Larva from above, with caudal filament partly exerted.  
„ 21.—Larva from the side, with caudal filament retracted.  
„ 22.—Larva from the side with caudal filament exerted.

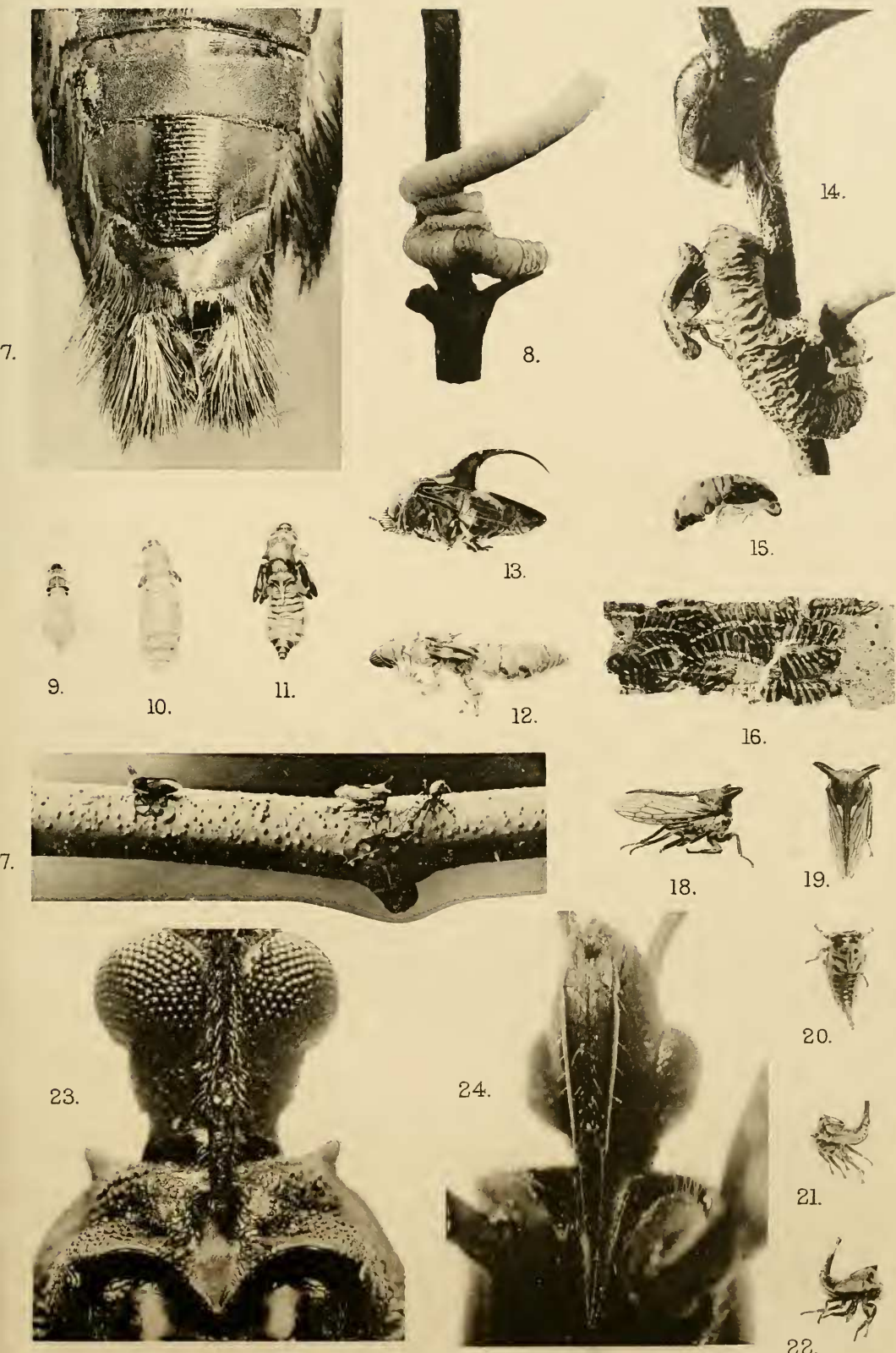
### *Conorhinus rubrofasciatus.*

- „ 23.—Head and prothorax from below, showing stridulating organ.

### *Ectomocoris cordiger.*

- „ 24.—Head and prothorax from below, showing stridulating organ.





EXPLANATION OF PLATE XXIV.

*Thelyphonus sepiaris.*

FIG. 25.—Courtship “dance”; first position.

„ 26.—Courtship “dance”; second position.

*Schizomus crassicaudatus.*

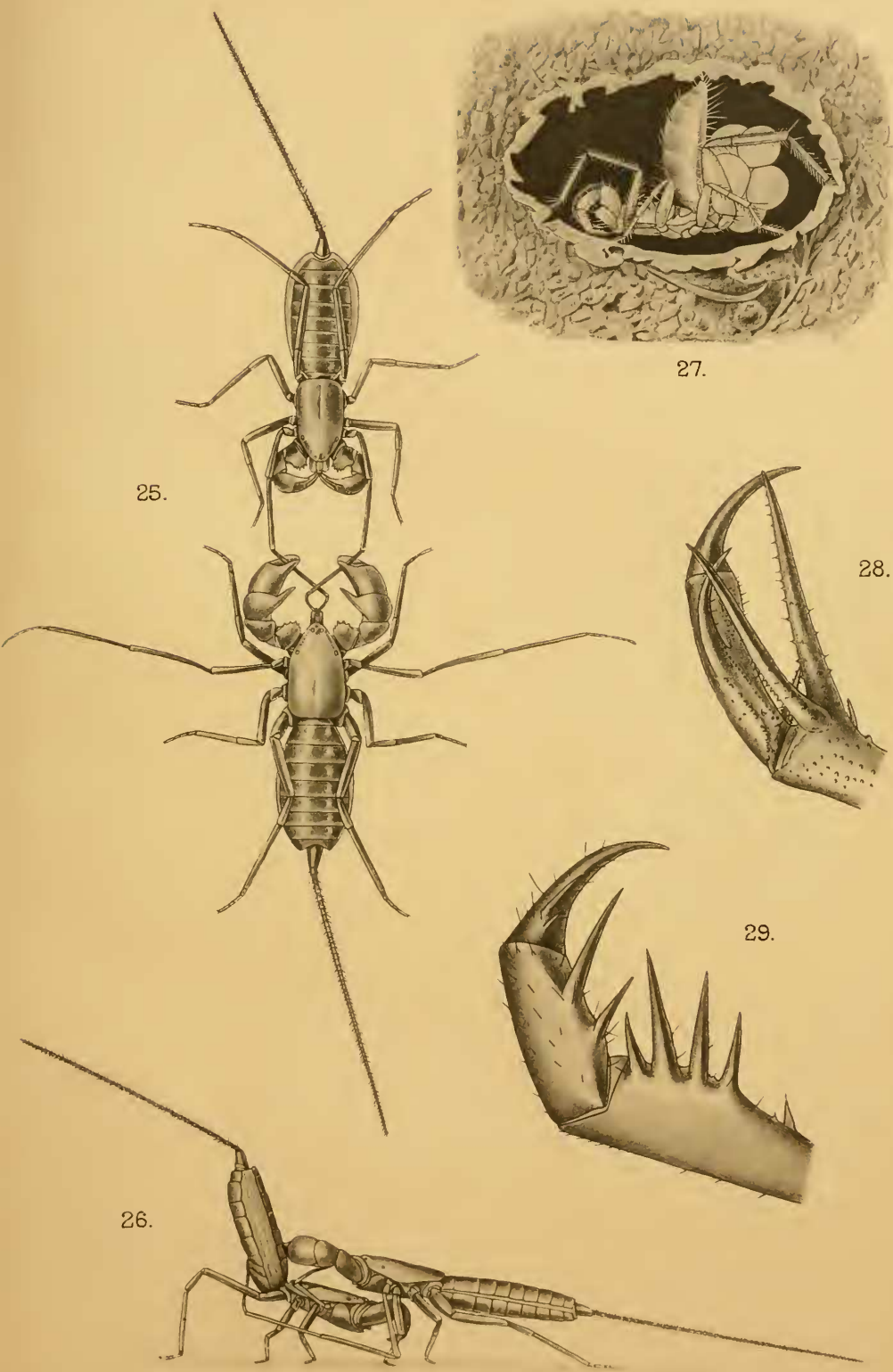
„ 27.—Female with eggs in underground nest.

*Phrynichus ceylonicus*, s. str.

„ 28.—Closed hand from above.

*Charinides bengalensis.*

„ 29.—Closed hand from above.



EXPLANATION OF PLATE XXV.

*Stegodyphus sarasinorum.*

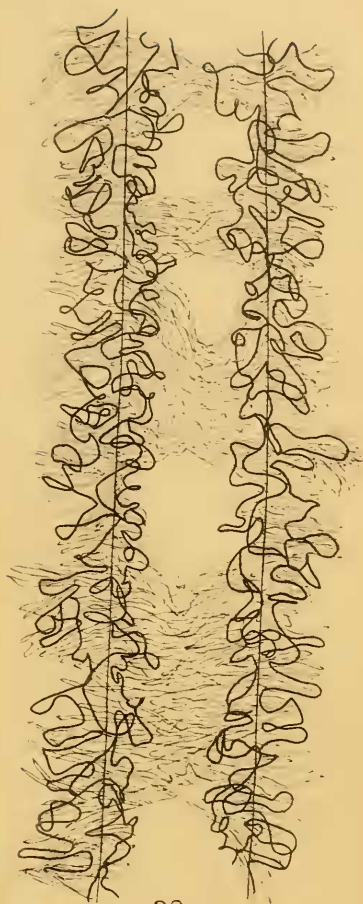
- FIG. 30.—General view of a nest, with small snares stretched between some of the outstanding leaves and the lower part of the stem of the plant on which it is constructed. (Much reduced).
- „ 31.—Part of a snare, magnified to show its structure.
- „ 32.—A double line of sticky silk, more highly magnified to show its component parts.
- „ 33.—A double foundation line overlaid by sticky silk, still more highly magnified, showing the various thicknesses of silk used in making the snare.



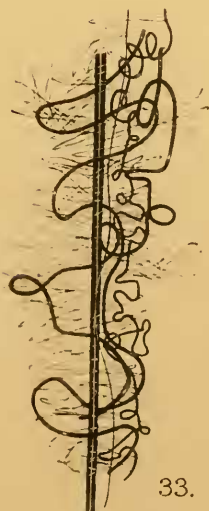


30.

31



32.



33.